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30 March - 1 April 1978

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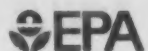
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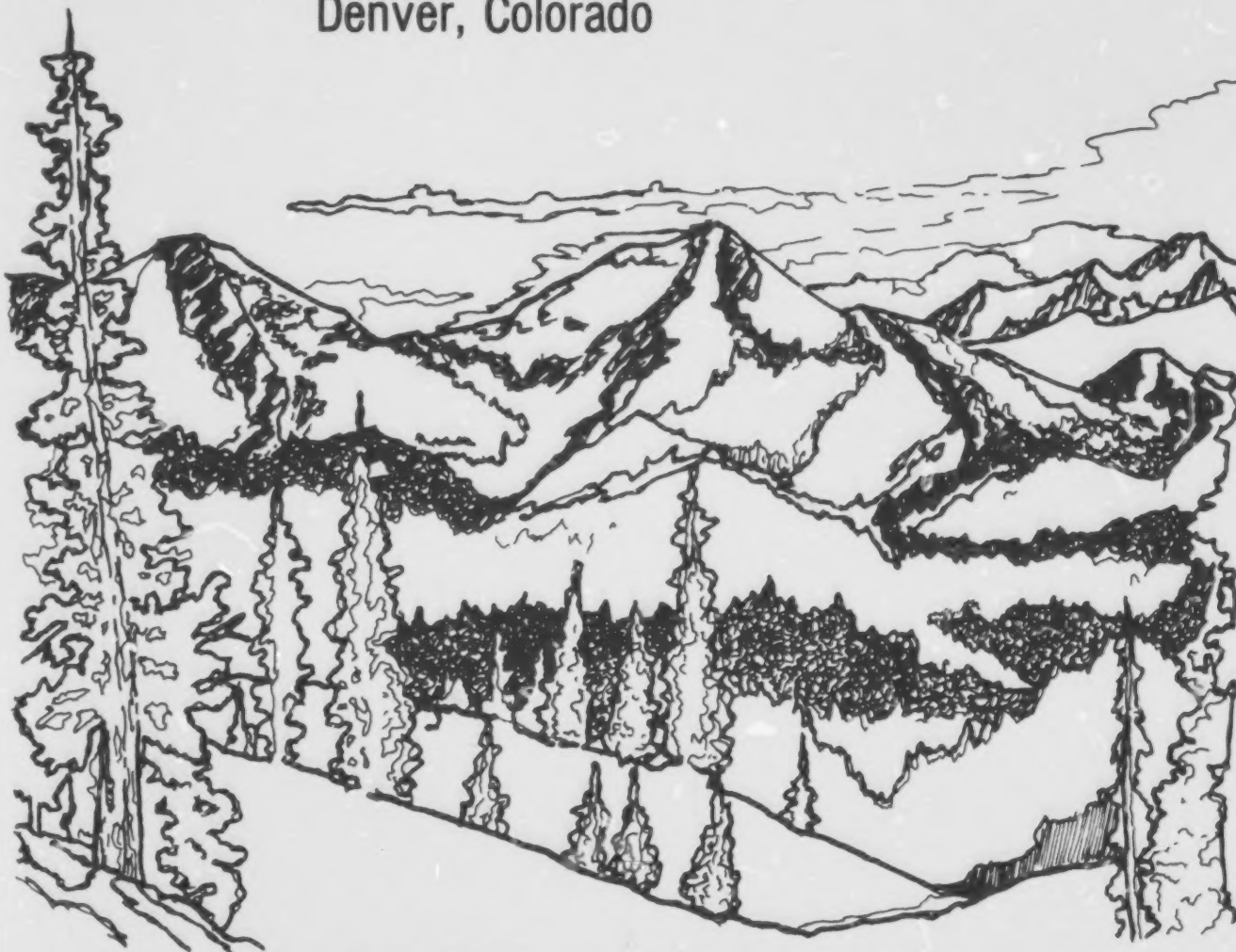
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PROCEEDINGS OF
A PUBLIC FORUM ON
ENVIRONMENTAL PROTECTION CRITERIA
FOR RADIOACTIVE WASTES

30 March - 1 April 1978

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Sponsored by
Office of Radiation Programs
U.S. Environmental Protection Agency

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PREFACE

The Environmental Protection Agency has been empowered to provide radiation protection guidance for use by Federal agencies which develop standards for various radiation exposure circumstances. This authority was transferred to EPA from the former Federal Radiation Council by Reorganization Plan No. 3 on December 2, 1970. Presently, EPA's Office of Radiation Programs is developing environmental protection criteria for radioactive wastes to ensure protection of public health and the general environment.

To facilitate public input to this program, EPA has sponsored two public Workshops (held at Reston, Virginia, on 3-5 February 1977 and at Albuquerque, New Mexico, on 12-14 April 1977) and the Forum reported herein. Each was attended by approximately 300 individuals, representing public interest groups, government, industry, and academia.

The two Workshops were general and were designed to allow the public to identify and discuss the issues regarding radioactive waste management which they perceived as relevant to environmental criteria. The output of those workshops was utilized by EPA in the preparation of its initial formulation of environmental protection criteria, which was published as Background Report--Considerations of Environmental Protection Criteria for Radioactive Waste (February 1978). The third meeting, the Denver Forum, was intended to focus on this Background Report and to provide recommendations to EPA on ways to improve the initial formulation of the criteria before the Agency puts forth formal proposals later this summer. The purpose of this document is to record in summarized form the proceedings of the Denver Forum.

INTRODUCTION

The Environmental Protection Agency is currently conducting a program to develop environmental radiation protection criteria and generally applicable environmental standards for radioactive wastes. These environmental radiation protection criteria for waste management will consist of general policy statements, which detail the basic philosophy, conditions, and issues that will be considered and reflected in the development of generally applicable environmental radiation standards and in the selection of appropriate waste disposal technologies and sites. The generally applicable environmental standards for specific sources of radioactive wastes will provide numerical limits that necessarily will be implemented by the Department of Energy (DOE) and the Nuclear Regulatory Commission (NRC) through their respective responsibilities in the field of radioactive waste management. In addition to these activities, additional standards will be developed as required by the Ocean Dumping Act and the Resource Conservation Recovery Act.

In the program to develop environmental protection criteria for radioactive wastes, EPA recognized that certain human value judgments would have to be made. Formulation of criteria, it is felt, would best include input from the public, industry, academia, and the responsible Federal and State authorities.

As mentioned in the preface to this document, two public workshops were held by EPA prior to the Denver Forum. Proceedings of those workshops are available, free, by writing to the EPA Office of Radiation Programs. Please refer to the Reston Workshop as U.S. EPA Report ORP/CSD-77-1 and the Albuquerque Workshop as U.S. EPA Report ORP/CSD-77-2.

The first day of the Denver Forum included three topical presentations by members of EPA's Office of Radiation Programs (ORP). These presentations were designed to provide the rationale established by EPA in arriving at its initial formulation of environmental criteria. Consequently, three separate working groups were formed to review and provide recommendations on the initial form of the criteria as published in the Background Report for the Denver Forum entitled "Considerations of Environmental Protection Criteria for Radioactive Waste." During the first two days, the working groups each convened for three discussion sessions, which were presided over by moderators unaffiliated with ORP. The moderators allowed the working groups autonomy, within the boundaries of order and relevance to the topic of discussion. After the general sessions, each working group outlined the contents for its summary report and selected a committee to write it. On the final day of the Forum a review period was scheduled to permit each entire working group to evaluate its report and agree on any changes before finalizing it. During the final plenary session, a selected participant read each working group report and the report committee fielded questions from participants.

This document serves as a record of the proceedings of the Denver Forum. It is divided into three topical sections, each made up of a statement of issues and objectives of the working group, the summary and conclusions of the working group, and the responses of Forum participants to the working group's summary and conclusions. Prepared statements from the public were accepted for ten business days following the Forum and they have also been included in this report.

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The Agency will consider those comments put forth by the participants at the Denver Forum and other submitted statements before publication of environmental criteria in proposed form later this year.

ADDRESS TO THE FORUM

Hon. Gary Hart

U.S. Senator (Colorado)

Nuclear waste disposal is one of the most serious environmental and public health issues facing our country today. Some say it is the Achilles' heel of nuclear energy. This matter is so serious that, if an acceptable solution is not found, we may be forced to look seriously at halting further development of nuclear power as an energy resource.

Yet, for thirty years, since the dawn of our atomic age, we have failed to come to terms with this problem. We have failed to find permanent, safe, and acceptable solutions. We have failed to include the cost of waste disposal in the projected cost of nuclear energy. We have failed to outline government or industry responsibility. And we have failed to confront the frightening long-range implications of having created a substance that will last thousands of years longer than all recorded human history.

We are here today to give this issue the high priority and focus it requires.

We have been accumulating nuclear waste since 1945, when the first atomic bomb was exploded. Today we have 50 million cubic feet of radioactive waste -- enough to make a pile 1,000 feet high on the football field at Denver's Mile High Stadium.

Since the first commercial nuclear power plant went on line at Shippingport, Pennsylvania in 1957, we have accumulated 5,000 tons of commercial waste, and each of the 68 nuclear reactors in use today is adding to the waste problem at the rate of 30 tons per year.

Yet, to this day, we have no plan for the safe and permanent disposal of any of these nuclear wastes. All of our solutions have been temporary--merely holding actions waiting for the right solution, the right policy, or the right time.

The stakes involve more than public health and the environment. Our energy future is at stake too. Sixty-eight nuclear reactors are operating in this country today. By the year 2000, nuclear advocates project 500 reactors contributing to energy supplies. But recent trends indicate we may never reach that goal. Expansion of nuclear energy facilities is absolutely dependent on location of nuclear waste repositories satisfactory in every sense.

The political climate is changing. The public and its elected representatives will demand a halt to nuclear energy development if answers are not provided.

In fact, the public reaction to the nuclear waste problems has already surfaced in several states. As a result of plutonium leakage from Maxey Flats, Kentucky may ban nuclear waste disposal within the state. There is strong support for a similar move in Illinois, even though half its electricity comes from nuclear power. And California, by law, has prohibited licensing any more nuclear power plants until a method has been demonstrated and approved for permanent disposal of high-level nuclear waste.

It comes down to this: We must devise and build a nuclear waste repository which will handle all of the waste we have now, as well as that we will generate in the future. That repository must be capable of safely isolating nuclear wastes from man and the

environment. And that repository must last for thousands of years without relying on inspectors or guards to maintain it.

Most scientists believe that safe, permanent storage is feasible, and various ideas have been explored. We could shoot the wastes into outer space; we could store them on the ocean floor; or we could bury them in deep geological formations. Yet, despite the fact that we have produced nuclear weapons for 30 years and used nuclear power for 20, none of these possible solutions has been satisfactorily developed.

For years, the government has promised that a final solution was just around the corner. As early as 1955, the Atomic Energy Commission directed the National Academy of Sciences to study the problem and find a solution. Seventeen years later, in 1972, the AEC began talking about building a permanent geological storage facility and set a date in the early 1980s. Then, in 1976, the Administration [ERDA, successor to AEC] was forced to revise its schedule and called for the establishment of a geological repository by 1985. It now appears even that timetable cannot be met. Just two weeks ago the Department of Energy announced that the 1985 deadline for building a waste disposal facility will be delayed a minimum of three years.

With growing amounts of nuclear wastes in temporary storage, this kind of open-ended delay is disturbing. And, it is all too reminiscent of the flawed history of our past nuclear waste management efforts.

To date, we have avoided disaster. Despite the lack of a clear and concrete nuclear waste program, there have been no immediate casualties and there has been no wholesale contamination of large parts of our environment. But short of that, we have compiled a complete catalogue of errors.

Undertakings by the nuclear industry have failed. In West Valley, New York, an industry fuel reprocessing project was abandoned in 1972 when resolution of safety concerns made the venture unprofitable. It will cost over half a billion dollars to clean up the West Valley plant and dispose of the orphaned high-level radioactive wastes in temporary storage there.

The government, too, has made costly mistakes. Despite the long history of our nuclear weapons program, 70 million gallons of high-level waste are still in temporary storage in Washington State and South Carolina. Over a half million gallons of this corrosive and toxic liquid have leaked out of steel containers onto the ground. Moving the rest of the waste into permanent storage will cost the taxpayer almost \$20 billion.

Nor have federal regulations been adequate to confront the problem. In the absence of government standards, builders used cheap, but radioactive, uranium mill tailings to construct homes and schools in Grand Junction, Colorado. Cleaning up that mistake is costing the taxpayer over \$15 million. At least another \$100 million will have to be spent cleaning up exposed and unattended mill tailings at 19 other sites around the country.

Federal attempts to solve the problem have been futile. In two states, Kansas and Michigan, attempts to find a waste repository had to be aborted because of public outcry against exploratory testing.

These mistakes and others led the government's General Accounting Office to conclude that progress toward placing wastes in deep geological sites "has been negligible to date"

and that "future program goals are overly optimistic because the administration faces many unsolved social, regulatory, and geological obstacles."

All of this adds up to our having created a monster with no cage to keep it in. Building that cage is a problem which must be solved and solved soon.

Last week, the Senate Subcommittee on Nuclear Regulation, which I chair, began a series of hearings on nuclear waste management. The end result of these hearings should be comprehensive legislation to deal with some of the roadblocks to satisfactory resolution of the waste disposal problem.

One problem we have identified already is the regulatory jungle surrounding our nuclear waste efforts. Federal authority to regulate nuclear waste is confused and inadequate.

Although the Nuclear Regulatory Commission has the primary responsibility for ensuring safe disposal of nuclear waste, there are significant gaps in NRC's authority to license and regulate nuclear wastes. Uranium mill tailings, federal R & D waste facilities, and short-term storage of high-level military wastes are just three of the more than a dozen examples identified at the Subcommittee's hearing last week.

I will introduce legislation to fill these gaps and give the Nuclear Regulatory Commission the authority it needs to license and regulate all forms of nuclear waste.

But developing a Federal nuclear waste management program involves more than legislation to fill the gaps. The Federal agencies with the regulatory authority must do their part, too. The Environmental Protection Agency must formulate the general environmental criteria for nuclear waste management. The Nuclear Regulatory Commission must develop its licensing regulations. And the Department of Energy must build the repository facilities. Or, put another way, EPA has to set the speed limit; NRC must control the throttle to stay within it; and DOE must build and maintain the car.

You are here to help accomplish the first task--to participate in developing EPA's criteria and standards for protecting public health and the environment against nuclear contamination. The results of your efforts will enable the EPA to "set the speed limit." Without this effort, the waste management program cannot proceed.

Environmental criteria for radioactive waste disposal are urgently needed. They have already been more than five years in coming. Surely EPA can achieve the goal of adequate public participation and at the same time propose regulations before another year is past.

EPA'S WELCOME

W. D. Rowe, Ph.D.

Deputy Assistant Administrator for Radiation Programs
U.S. Environmental Protection Agency
Washington, D.C.

Ladies and Gentlemen: It is my pleasure to welcome you to EPA's Public Forum on Environmental Protection Criteria for Radioactive Wastes. We sincerely appreciate your participation.

We think Denver is a particularly good location for this Forum since it is accessible to a good representation of the interested public, and because a number of waste management problems exist in this general region.

As many of you know, we have already held two workshops on this subject: one in Reston, Virginia, in February 1977, and the other in Albuquerque, New Mexico, in April 1977. Those meetings identified issues of concern for developing criteria, and we believe we have fairly used the output of those workshops in preparing the initial formulations of environmental protection criteria to be discussed in this Forum.

I want to emphasize at the outset that the initial formulations are just that. We expect your discussion and recommendations to result in revisions and perhaps the addition or deletion of subjects addressed by the criteria before they are formally proposed. We believe your input is essential to true public participation in the development of Federal policy. We will revise these criteria to reflect the results of your discussion, and only then will they be issued as a formal EPA proposal. Consequently, they are still in a developmental stage.

In regard to suggestions made at the previous workshops, we purposely scheduled this Forum to include Saturday sessions and evening sessions tonight and tomorrow evening so that interested people in the local area who have regular daily jobs can have sufficient time to participate. We will do appropriate recapping at the beginning of each evening session so that those people who can only attend outside normal working hours will be able to keep abreast and contribute.

The basic format for the Forum emphasizes working sessions, which will begin after a short plenary session this afternoon. We will divide into three or more working groups, depending on the number of interested participants. EPA will provide moderators for these sessions strictly to provide order and nothing else. We believe the working group method provides the maximum opportunity for individuals to participate actively. This format means that all the information and consensus opinions brought forth at this Forum are entirely up to you. We hope to receive extensive discussion of the Background Report, "Considerations of Environmental Protection Criteria for Radioactive Waste"; you can of course introduce any new material you believe is basic to formulating environmental protection criteria for radioactive waste.

The Agency will utilize your recommendations from this Forum in the preparation of a formal proposal for environmental protection criteria. Those proposed criteria will then appear in the Federal Register for formal public comment. The formal proposal will be made pursuant to the broad Federal radiation guidance authority which was transferred to EPA from former Federal Radiation Council.

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The criteria we will propose can best be described as generalized policy statements that address the key value judgments on issues that must be explicitly considered in the development of basic philosophy, policy, and conditions for establishment of environmental and public health protection standards for radioactive waste disposal. The issues involved cover moral, social, and technical problems that must be addressed. There are no "right" answers to be expected, but a series of value judgments reflecting consideration of all sides of the issues which have been aired extensively through an open public process.

Moral value judgments involve issues such as "Should we treat future generations differently from our own?" and "Should environmental nondegradation be a major objective, that is, should we subscribe to a philosophy of containment rather than dispersion?"

Social value judgments involve issues such as the balancing of risks to future generations for benefits received now, how long institutional controls may be relied upon, and how long into the future we can estimate risks on both absolute and relative bases.

Technical value judgments involve such problems as what models we can use to estimate present and future risks, and how we characterize and make meaningful decisions in the face of large uncertainties.

Three criteria in our initial formulations address many of these value judgments explicitly:

1. The goal of waste management should be containment of wastes to prevent environmental degradation over the hazardous lifetime of the wastes, rather than dispersal.
2. Institutions should not be depended on to provide environmental protection from radioactive wastes for more than a given period of time (e.g., 100 years) by limiting public access, etc.; following that period, no restrictions on customary uses of associated land areas and surface and ground waters should be required ("the institutional criterion").
3. Risk estimates are to be the primary determinants for decision; these should be performed for human individuals and populations for a period of at least 1,000 years on an absolute basis; where estimates of adverse effects for longer periods could significantly influence selection of a disposal option, relative risk assessments would be meaningful (the "risk assessment criterion").

Absolute risk estimates depend upon models and hypotheses of what the future will be like. Relative risk estimates are less sensitive to such model assumptions, but allow us to ask the "what ifs" for various options in a useful way. These concepts are not easy to describe, but I have discussed some of the problems inherent in using absolute and relative risk assessments in a document entitled "Rationale for Establishing Risk Acceptability Levels for Radioactive Waste Criteria." Copies of this document are available for you.

Both the timeframes and the substance of these criteria represent initial formulations and are subject to discussion and change as a result of this Forum.

EPA's standards, which will be numerical performance requirements, will be based upon the criteria that are eventually developed from this process. The first numerical standard the Agency will develop will be for high-level radioactive waste. This effort will be followed by generally applicable environmental standards for low-level wastes,

uranium and phosphate mining and milling wastes, and wastes from decommissioning. Such numerical standards will be neither site- nor method-specific. The regulation of waste management operations rests with the Nuclear Regulatory Commission (NRC), whose regulations when promulgated will assure that EPA standards are met.

We will devote the remainder of this session to presentations by EPA on the initial formulations of the criteria. The EPA staff presentations are designed to provide our perspectives and reasoning in arriving at the criteria formulations. Also, the first Working Group sessions are scheduled to begin this evening. The objective of tonight's Working Group sessions is to establish the format and the agenda to be used for discussion throughout the entire Forum.

I hope that our combined efforts will make this third Forum the most productive to date. Thank you for your attention.

TOPIC I

WHAT IS RADIOACTIVE WASTE?

CRITERIA FOR DESIGNATING MATERIAL AS RADIOACTIVE WASTE: A STATEMENT OF ISSUES AND OBJECTIVES OF WORKING GROUP I

Harry J. Pettengill, Ph.D.
Waste Environmental Standards Program
U.S. Environmental Protection Agency

INTRODUCTION

When EPA was formed in 1970, one of its charges was to "advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for Federal agencies in the formulation of radiation standards..." This responsibility includes protection of the public health from potential hazards associated with the various forms of radioactive waste. The Agency has established a program to provide such guidance through the development of environmental protection criteria for all types of radioactive waste.

In developing our initial formulations of draft environmental criteria, EPA was especially mindful of issues and recommendations from our two previous public Workshops held in Reston, Virginia, and Albuquerque, New Mexico, in early 1977. Since then we have thoroughly researched issues discussed at the Workshops and other relevant ones in our attempt to determine those considerations that need to be addressed in the criteria.

The issues EPA has dealt with in its Background Report* and the initial formulations of criteria are (1) features of radioactive materials that require them to be designated as radioactive wastes and their hazard potential over time and at various levels of controls, (2) the importance of risk estimates in arriving at levels of control and the factors that should be reflected in such determinations, (3) the goals of control and the types of institutional, engineered, and natural-barrier controls for meeting such goals, (4) the approaches for determining the allowable levels of short- and long-term risks associated with various means of disposal for varying types of waste materials, and (5) other considerations for environmental protection, such as retrievability, monitoring, and the transfer of information to succeeding generations.

Obviously, the first consideration in putting forth criteria for radioactive waste is to determine what they apply to. This requires a clear distinction as to what constitutes radioactive waste materials and the basis for designating certain materials as such. This presentation is a brief overview of the areas and items reviewed by EPA with respect to the first chapter in the Background Report and the first criterion. The discussion of the other key factors such as risk perspectives, control technology, long-term implications, and other operational controls will be discussed by other speakers on today's program.

WASTE CATEGORIES AND INVENTORIES

EPA has reviewed and, as you will note in the Background Report, documented a wide range of sources and inventories of radioactive wastes that were considered in formulating the criteria. Some are artificially produced and others result from activities involving naturally occurring radionuclides.

*Background Report--Considerations of Environmental Protection Criteria for Radioactive Waste. February 1978. Waste Environmental Standards Program, Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Those in the first group, artificially produced, result mainly from activities within the nuclear fuel cycle, i.e., reactor operations and spent-fuel reprocessing, and from medical and industrial sources. Traditionally, these radioactive wastes have been referred to as being either high-level or low-level. The major sources of the high-level wastes are the spent fuel and/or the by-products of reprocessing of the fuel, with the Federal government having generated, at this time, over 98 percent of the volume of those wastes.

"Low-level" waste has generally been a catch-all category for wastes, including everything other than high-level, and covers a broad range of origins and many different substances. Again, the Federal government has generated over 75 percent of the existing volume of low-level wastes.

Wastes containing naturally occurring radionuclides result mainly from the mineral extraction and processing industries--primarily uranium, thorium, and phosphates. There are over 400 million tons of uranium and phosphate mill tailings presently accumulated in this country, with the uranium industry accounting for about 32 percent of that quantity.

HAZARDS FROM RADIOACTIVE WASTE

In looking at the hazards of various types of wastes, we find that high-level wastes typically present both an external gamma radiation hazard, and, in the event of an uncontrolled release, an inhalation and ingestion hazard. Acute exposures are the concern with high-level wastes because of the activity level and the highly penetrating gamma radiation. The gamma radiation is produced mostly by short-lived fission products; therefore, after a few hundred years, the remaining predominant hazard from high-level wastes would result from ingestion or inhalation of the long-lived alpha emitters of such wastes.

Most low-level wastes would not present an acute hazard but, in the event of release to the biosphere, could present a potential chronic hazard to the public. The current practice of shallow land burial of low-level wastes means that the most probable hazard would result from ingestion, primarily through a water pathway. There also are some transuranics found in most low-level fuel-cycle wastes; however, these do not appear to be easily transported through most food chains and consequently would pose only a slight ingestion hazard. More likely, they would pose a greater hazard from inhalation during handling or from resuspension into the air.

Low-level wastes which contain naturally occurring radionuclides, because of their diffuse activity concentrations, typically represent a chronic rather than an acute exposure hazard. In the case of naturally occurring nuclides, the isotopes of major concern are Ra-226 and its daughters. Since radon is a gaseous daughter of radium, it diffuses readily into the atmosphere and presents a hazard due to inhalation.

WHAT ARE RADIOACTIVE WASTES?

Thus far, I have only summarized the materials, activities, volumes, and major potential hazards from wastes which contain significant levels of radioactivity. In our attempt to formulate a definition for radioactive waste, EPA put forth a "straw man" definition for discussions at our previous workshops. That definition stated, "Radioactive wastes are all retained radioactive materials of no immediate or foreseeable value generated as by-products of man's activities." Working Group 1 at the Reston Workshop responded to this proposition with the following recommendation:

EPA should not develop or define specific and detailed categories of radioactive waste. The following broad definition of radioactive waste (offered in full recognition of the existence of more detailed definitions) is proposed for the purpose of environmental protection criteria: Radioactive waste is all that radioactive material with respect to which a decision has been made by the cognizant authority to place the same in permanent storage or a permanent mode of disposal at discrete sites designated for those purposes, and shall exclude radioactive material for which a determination to withhold has been made. Also excluded are radioactive releases from facilities involved in production or reprocessing of nuclear fuel and the generation of electricity from nuclear fuel, which are subject to federal and state licensing and regulation. (Note: This definition does not preclude the possibility that materials designated as "waste" may or may not have value now or in the future.)

The first Working Group at the Albuquerque Workshop also deliberated this issue but was not able to reach such a clear consensus; however, they did state the following:

There was no agreement of how to determine that a waste had no future use which might affect management of that waste.

On one hand, there was concern that calling a material "waste" might lead to its irrevocable disposal, thus denying its value. On the other hand, some felt that a material might not be designated as "waste" to avoid the environmental control that designation might entail. It was noted that few (if any) methods of disposal are irrevocable if cost is no object. An objection was also made to the semantic implications of the terms high-level and low-level, in that they might misleadingly imply relative importance.

Likewise, EPA has viewed this issue from the aspect of its desire to cover all sources of radioactive waste materials under one general criterion. It is evident that there is a need to enumerate some basic assumptions in order to narrow the definition of radioactive waste, since almost any material could be designated as radioactive waste if the only requirement were that it contain measurable radioactivity. For example, the human body contains some quantities of isotopes such as K-40 and C-14. Therefore, we felt there was a genuine need to propose some baseline conditions to more realistically define a radioactive waste.

First, materials should be declared waste on the basis that they have no foreseen value. EPA has not made an attempt in the Background Document or its formulation of criteria to establish who should declare those materials as having no value. Obviously, this is an issue which will eventually require resolution.

Second, radioactive wastes should include only those materials under some form of regulatory control. Such a basis works well for source material and by-product materials covered by the Atomic Energy Act, but one should recognize that other sources, such as some naturally occurring radioactivity and accelerator-produced nuclides, are not so clearly under strict regulatory control. However, current activities and regulations being developed under the Resource Recovery and Conservation Act of 1976 and the Clean Air Act as amended in 1977 may provide a mechanism for regulation of such materials.

As a third consideration we felt that, because naturally occurring radioactivity is ever present in the environment, some basic differentiation was needed between naturally occurring radioactive materials and nuclear wastes of human manufacture. In differ-

entiating between these two types of waste we reasoned that if the waste materials contained naturally occurring radioactivity but nothing was done to make that radioactivity more accessible for exposure of humans than under normal natural conditions, then any radiological impacts due to the management of such wastes would be of limited importance. This, in essence, classifies some types of waste materials as being non-radioactive waste for practical purposes, even though there may be trace amounts of naturally occurring radionuclides involved.

Using this philosophy one should be able to assume that disposal of any material containing naturally occurring nuclides which would not increase the pre-existing exposure level to humans via any pathway would not require special care strictly on the basis of radioactivity.

The final consideration is that human-produced nuclides under specific regulatory control (including discrete radium sources) should be assumed to be radioactive waste where there is no longer a use for such materials. The reason that our initial formulation of a criterion for radioactive wastes is so encompassing for human-produced radioactive materials is our belief that such materials are already controlled to reduce potential human exposure, and that their control should be extended through eventual disposal.

DESIGNATION OF RADIOACTIVE WASTE

In summary we have put forth for your deliberation at this Forum a criterion for defining radwaste which states:

Radioactive material which has no designated resource or product value should be considered radioactive waste requiring environmental protection if it (a) is produced by nuclear fission or activation, (b) contains naturally occurring radioactive material that if disposed into the biosphere would increase exposure above that normally occurring in pathways owing to the natural state of the area, or (c) is restricted from routine release to the biosphere. Examples* of such radioactive waste materials that should be subject to environmental protection requirements are

all radioactive materials associated with the operation and decommissioning of nuclear reactors for either military or other purposes and the supporting fuel cycles, including spent fuel, fuel reprocessing waste, and radionuclides removed from effluents,

artificially produced radioisotopes for medical, industrial, and research use, including discrete radium sources, and waste materials contaminated with them, and

the naturally radioactive residues of uranium and phosphate ore recovery and associated milling and conversion operations.

* The EPA has determined that the materials listed should be subject to environmental protection criteria even though some such materials may not upon examination require any control above that they would receive as ordinary wastes; other radioactive materials may also be included if they are found to satisfy similar considerations.

SUMMARY AND CONCLUSIONS OF WORKING GROUP I

INTRODUCTION

The first session of this group was spent, following introductions and explanation of the task to be accomplished, in general discussion of the basic topic. After the break, a tentative agenda was identified. The agenda called for the group to develop, that evening, a list of issues to be discussed the following morning. The Friday afternoon session was to be devoted to discussion of the content of the Background Document. It was later found that the group's interest was centered on the list of issues developed, and, since the background document would be rewritten as a result of the Forum, a detailed discussion of the document was deleted from the group's agenda.

The provided list of suggested topics was augmented by the group at the first session to cover not only the criterion of the definition of radioactive waste but also a limited number of issues under the criteria being addressed by Working Groups II and III. Additionally, a small list of general issues was developed. This report summarizes the issues identified by the group and its concerns for how these matters might be addressed in the criteria and by EPA. A total of 25 issues were identified.

DEFINITION OF RADIOACTIVE WASTE ISSUES

- A. How are the criteria to be used by the standard-setting agencies in the development of their individual regulations and manual chapters?

The group was given to understand that the criteria developed by EPA could be used by EPA in the development of their own regulations and possibly as guidance to other federal agencies in the development of specific regulations implementing the basic philosophical statement. States having agreements with the Nuclear Regulatory Commission (NRC) for regulation and control of certain radioactive material would most probably be required to adopt similar regulations compatible with the NRC and the criteria if implemented. Some people felt that individual states should have the right to promulgate stricter regulations.

- B. Are the criteria as presently suggested considered adequate for development of standards?

It was the general consensus of the group that, owing to the number of issues available for discussion and the divergent opinions of the participants, the criteria were currently unacceptable.

- C. How could the term "radioactive waste" be more simply defined?

An opinion of the group was that the criteria should consider all radioactive material regardless of origin, i.e., manmade and naturally occurring materials, and that the material should not have resource or product value. Some felt that resource or product value should not be included in the definition. The matter of who designates a waste and when a material becomes a waste was addressed under Issue D.

- D. Should the criterion attempt to address the designation of no resource or product value, and who should make that decision?

It was suggested that the licensee or possessor of the radioactive material identify the value or nonvalue of a source and that the regulatory agency involved review such determinations for appropriateness. It was also suggested that a time limitation be considered on the determination of planned use or value and that the inventory be continually updated to reflect properly the full scope of the possession of radioactive material. An assignment of use or value shall not exempt the radioactive substance from regulatory control. The question of spent fuel being a waste or having resource value was a point of contention.

- E. When is a radioactive waste material no longer considered radioactive by virtue of decay processes?

It was the opinion of the group that the basis for such a decision would be addressed by the discussion of Issue F.

- F. Should EPA specify in the criteria a minimum level of radiation or radioactivity for defining radioactive wastes?

The group felt that such a designation should be included in the criteria and that it could take several forms, i.e., a level for each radionuclide or classification of radioactive material. An opinion was also expressed that, owing to the nonthreshold philosophy, no acceptable minimum level could be identified. The method of determining a minimum level was discussed under Issue G. Some people felt that when the minimum level for the material is reached by decay, the material may be disposed of as nonradioactive waste. Others felt that the label "radioactive" must remain with the material.

- G. What methods could be used to derive a minimum level?

The following methods were suggested by the participants: as multiples or fractions of natural background radiation; as radiation doses with consideration of the pathways involved versus the measurement or calculation of radiation levels; as a statement of absolute values; and in terms of anticipated health effects. Consideration should also be given to the worst radionuclide that may be involved in a radioactive decay chain.

- H. When is ultimate radioactive waste disposal requested or required?

Since the issue as originally drafted did not stipulate "ultimate" disposal, discussion included whether storage should be considered or whether the term "disposal" should be replaced with the term "waste management." With the insertion of the word "ultimate," there was a controversy as to whether ultimate disposal could be required if an acceptable method of ultimate disposal has not been demonstrated or proved. The implication is that if an acceptable method of disposal is proved then the criteria should possibly address when specific disposal would be required. Some people felt that ultimate radioactive waste disposal should be required, and that if it cannot be provided, then further radioactive material should not be produced.

- I. Do current regulations provide assurance that radioactive materials that are restricted from routine release to the biosphere will be properly classified as waste?

The consensus of the group after discussion was that the current regulations do not adequately address the designation of waste. There was concern expressed that routine

effluent discharges be included in the definition of radioactive waste. There was also discussion to the effect that standards for routine releases for the uranium fuel cycle are already in place (EPA regulation 40 CFR 190).

- J. Should the criteria address human contamination such as excreta and body burdens of radioactive materials?

It was the opinion of the group that the subject of human contamination should be addressed in the criteria. Some felt that current procedures and regulations are adequate to control the disposition of excreta from persons who had undergone diagnostic or therapeutic use of radioactive materials.

- K. Is the rationale for the classification of wastes on the basis of preexisting natural levels of radiation reasonable?

If acceptable minimum levels of radiation to humans are defined in the criteria, then there appears to be no need to define radioactive waste with respect to preexisting levels.

- L. Should redistributed naturally occurring radionuclides that increase human exposure be considered radioactive waste?

The group concurred that such material should be considered for inclusion in the criteria. Some felt it should definitely be included.

- M. Should there be distinctions between high- and low-level wastes in the criterion defining radioactive waste?

It was felt that distinctions should not be included in the definition of radioactive waste, but that they should be incorporated in the criteria addressing the control measures or in the standards promulgated by the regulatory agencies.

- N. Should there be more categories of radioactive wastes?

It was felt that, in the context of the definition of radioactive wastes, multiple categories should not be considered.

- O. How do the criteria specifically address the definition of past, present, and future radioactive wastes?

The criteria should definitely address the wastes generated in the future, and in some cases should consider past generation of wastes and their disposal. The consequences of exhumation of past disposals must also be considered. The treatment of wastes generated in the future should be dealt with on the basis of knowledge gained about the biologic effects of radiation.

- P. Should the criteria address activated and/or absorbed radioactive materials that are not currently addressed by standard-setting agencies?

It was the consensus of the group that all radioactive materials regardless of origin be included in the criterion defining radioactive waste and that they be appropriately addressed in regulatory documents.

- Q. When is the packaging material for radioactive waste considered a radioactive waste?

It was the feeling of the group that if packaging materials are somehow contaminated or included in the actual disposal technique, then the packaging materials, regardless of the type of material, must be considered as a radioactive waste. However, if a container that may have a value can be safely reused, then that container would not be considered radioactive waste.

DISCUSSION OF ISSUES OF WORKING GROUPS II AND III

- R. What risk is acceptable for radioactive waste disposal?

Since there were considerable differences in opinion on this matter, the issue could not be properly addressed or resolved in the time provided. Some individuals expressed an understanding and acceptance of what would constitute an unacceptable risk, such as is suggested in the background document. Others expressed concern that an acceptable risk could not be identified because of the long-term implications that may be involved and the lack of an adequate data base.

- S. Should there be a discounting of risks to future generations? How could this be equitably accomplished?

Some members of the group felt that risks to future generations should not be discounted. Others felt they should.

- T. Should the criteria consider theories of risk other than the linear hypothesis?

The group felt that the criteria should consider other theories on the basis of the data that support them.

GENERAL ISSUES

- U. Should the production of radioactive wastes be allowed to continue?

It was concluded that an across-the-board "No" cannot be given. Consider Issue V.

- V. Should there be a moratorium on nuclear power in the U.S. until a satisfactory waste disposal technology has been approved?

The group provided strong opinions--both positive and negative--on the issue of a moratorium. The definition of a "satisfactory technology" and who should approve the technology also brought diverse responses. Suggestions included a decision by the general public, Congressional approval, and deciding "acceptability" according to governmental rules of procedure. It was suggested by some that there should be broad public participation and funding to present views of environmentalists.

- W. What is the actual goal of ultimate disposal of radioactive waste?

The group concurred with the first sentence of Item 4, page 52, in the Background Report: "Controls should be applied with a goal of isolating radioactive wastes from the biosphere over their hazardous lifetime to protect humans and minimize unnecessary contamination of the environment."

X. What should be EPA's format for broader public participation in the development of criteria?

The suggestions for increasing participation were

1. that public hearings be held in every state at convenient times (e.g., weekends and evenings) and places for the general public,
 2. that all media be involved in publicizing the hearings and that the hearings themselves be televised,
 3. that materials be made available on semantics and terminology in advance of the hearing,
 4. that town meetings have been successful in the past and might be used,
 5. that a jury be selected and that this jury be educated by advocates of the various points of view to a very high level of understanding of the subject so that jury members could discuss the issues and come to a consensus, which would be made public through the press and television,
 6. that discussions not demand the understanding of sophisticated technologies,
 7. that legislative bodies, including Congress, deal with these problems instead of the general public, and
 8. that there be more participation of scientists who have no vested interest, and that financial aid be provided to representative people.
- Y. Additional suggestions were that an open forum be held on the subject of the nuclear industry and that public forums encourage the use of small group sessions.

ACKNOWLEDGMENTS

The entire group was instrumental in formulating the final draft of this report. We wish to thank EPA's facilitators and Al Hazle, our excellent moderator.

WORKING GROUP I PRESENTATION COMMITTEE

<u>Name</u>	<u>Affiliation</u>
Michael Buring	Reading (Pennsylvania) Utility
Frances Connor	Rocky Flats Monitoring Committee
Judy Wilkinson	Boulder Mobilization for Survival

RESPONSES OF FORUM PARTICIPANTS TO SUMMARY
AND CONCLUSIONS OF WORKING GROUP I

Second Plenary Session

LARRY C. OYEN (Sargent & Lundy) [comment on Item G of Summary and Conclusions]: Minimum levels of low-level waste should be considered. Low-level waste after some decay period should be considered nonradioactive. Criteria for this [are] being developed by an Atomic Industrial Forum contract to Nuclear Safety Associates. These criteria will state levels when radwaste reaches "de minimus" levels.

COMMENT ON ITEM M (name withheld): Any distinctions between high-level and low-level waste which are made in the criterion or in later standards should be based on determinations of toxicity and/or longevity of the wastes but not upon immediacy or acuteness of the health effects (i.e., velocity). Whether you die from low exposure or high exposure, slowly or rapidly, should not be a consideration--you are just as dead.

CYNTHIA BATES: First I want to say I'm very sorry about this. It was through an oversight that this came about. It's about [Item] M, which says "Should there be a distinction between high- and low-level waste in a criterion defining radioactive waste?" In our group, different people projected different issues that they wanted to discuss or comment on, and I projected this one, and I want to make a correction which I'm afraid will probably lead to some disagreement among the group, but I didn't intend it to be written at all this way...how I felt...the thing I was proposing was...I'll read it as I had proposed it: It was felt that distinctions should not be included in the definition of radioactive waste and they should not be incorporated in the criteria addressing the control measures or in the standards promulgated by the regulatory agency. In other words, all levels of radioactive waste would have a common disposal process involved, and I did...it was an oversight...I'm very sorry that I didn't notice this earlier. It was pointed out to me right before this meeting; I had no chance to really interact with my group about it. If there is disagreement with that I suggest that we...if there was a dissenting opinion...each opinion was presented on both sides. Our dissenting opinion in Group I is that the change be made; I suggest that we rewrite it in here. Is there any dissention from Group I about how that should be?

MIKE RAUDENBUSH: As a point of order, I would suggest that the summary document, for all its flaws, does represent what we agreed to submit and any changes should be in the form of follow-up minority statements.

DR. JAMES MARTIN, Chairman (Environmental Protection Agency, Washington D.C.): I'd have to support that, I'm afraid, because regardless of the understanding of the group that was the issue. They did write about the issue as they understood it. I would suggest if you have some comment or correction state it as yours. We are not going to start revising the reports here; we just don't have the time.

BATES: I'm very sorry.

ROY E. POST [comment on Item B]: In what way were the criteria unacceptable?

JUDY WILKINSON (panelist): The questions that we have outlined in the rest of the report go into some of the ways in which we feel that they were not acceptable. For some of us it was that we didn't feel good about the definition of waste as related to background material or background levels and about the distinction between high- and low-level waste. We didn't feel good about certain omissions such as...the omission of

human contamination or of containers and also about the definition of waste as excluding anything that could have resource value, and I'd like to hear what the other scientists say.

MICHAEL BURING (panelist): I don't think that I should add any additional material to what's in the report itself. I think that the viewpoints are pretty well summarized.

CAROLYN LANDES: Did the group really concur with sentence 1, Item 4, page 52 [of Background Report]?

FRANCES CONNOR (panelist): The answer, I believe is yes.

UNIDENTIFIED SPEAKER: [inaudible comment]

MARTIN: I'm sorry, you're off the record. That's the advantage of stating your question yourself. Please, let's move on. I don't want to get dictatorial, but many people are looking at their watches and we have a lot to go through.

WILKINSON: I say if we don't have time to do it, then we shouldn't be doing it. If we're going to do it, we ought to do it well.

LANDES: I remember opinions expressed that the goals of controls should be for zero contamination to the environment and effects on human health and future.

CONNOR: There were some opinions expressed [to this effect].

COMMENT ON ITEM I (name withheld): [Let us] change the second sentence in the conclusions on Item I to read "There was concern expressed that routine effluent discharges and abnormal or transient releases be included in the definition of radioactive waste."

DR. TOM ENGLISH (Jet Propulsion Laboratory, Pasadena, California): Issue D does not explicitly take into account two major factors: (1) President Carter has deferred reprocessing indefinitely. (2) Page 8 of the DOE Deutsch report places HIGHEST PRIORITY on demonstrating the ultimate disposal of spent fuel. Hence, spent fuel is a form of high-level radioactive waste.

BURING: No one can argue that President Carter has deferred reprocessing indefinitely; that's a known fact. There was considerable discussion as to whether spent fuel was a resource or a waste; did it have intrinsic value, which took it out of the waste category, or did it have no value and therefore [have to] be declared a waste? There were dissenting opinions, and we tried to reflect that in the report.

WILKINSON: We also said that, regardless of whether or not it was classified as a waste, it should be dealt with through government control.

JONATHAN WEISS (Decisions and Designs, McLean, Virginia): This really addresses Issue X. These are overall comments on the [Forum], not comments on the reports themselves. (1) Better efforts should have been made to publicize the Forum to the general public--the present group was too polarized. Perhaps [there should have been] some compensation or subsidy for participants, especially those who traveled long distances. (2) Smaller discussion groups (10-12 would be optimal)! (3) Discussion leaders were excellent, but the meetings should have had more background work done prior to convening. In particular, (a) tentative agendas and procedural rules, (b) clear

definitions of the scope of discussion and the terms used (e.g., "risk"), (c) perhaps a clearer statement of the desired format of the reports and of their use by EPA.

MARY SELL: I'd like to recognize the great efforts made by EPA to get public opinion, but I would like to also point that, at least two to one, the nuclear industry outnumbers the general public, so therefore the statement is not a public statement. I as an individual would like to have some reassurance from the EPA that my input will be used, that I wasn't just allowed to vent my feelings in order to cut down on very strong public activity at this time, anti-nuclear activity, and therefore defuse a public forum that is in action in the country at this time.

DR. WILLIAM ROWE (Environmental Protection Agency, Washington, D.C.): I guess I'm called upon to answer that one, and my answer is twofold. One, we don't count numbers from which side are here. [Two,] we count every individual and every comment and we listen to every individual and every comment.

SELL: Thank you, Dr. Rowe.

COMMENT ON ITEM K (name withheld): Omitted from the report on this item was the exception that definition of radioactive waste based on naturally occurring radioactivity or radiation level should not be interpreted as requiring the disposer of wastes to meet lower levels of such radioactivity than occurring at the disposal site.

PAUL H. LOHAUS [comment on Item B]: It does not appear that the "number of issues available for discussion" and "divergent opinions of the participants" should be the only basis for determining the acceptability or unacceptability of the criteria.

CONNOR: Well, that's your opinion.

ILENE YOUNGHEIN [comment on Item N]: I feel there should be multiple categories of waste, due to the various hazards of various elements.

JACK W. LENTSCH (Portland General Electric Co.) [comment on Item D]: The designation of spent fuel as a waste is a national policy decision that is subject to Presidential and Congressional mandate. It is quite incorrect to infer that a federal regulatory agency can designate spent fuel to be a waste.

STEPHANIE J. BAKER (Western Nuclear, Inc., Denver, Colorado) [comment on Item V]: Environmentalists represent special-interest groups who wish to maintain the status quo--i.e., environmentalists are a select few who want to retain their privileges. Special funding should not go only to environmentalists.

CONNOR: I think the intent of the group was that, as a broad category, "environmentalists" was mentioned as one group to receive [possible funding].

WILKINSON: In [Item] X we talked about public participation and pointed out that we wanted to have people who were representative of all points of view and of all sections of the country.

DR. FREDERICK FORSCHER (GASP Energy Committee): Radioactive material as a result of nuclear explosions (for instance, rubble, debris, etc.) should also be included in the definition of radioactive waste. Question: Is it included in the definition? It is not a future waste; it is present waste now, for instance in Japan.

WILKINSON: We weren't excluding present waste at all.

BURING: There was also the [opinion] that all radioactive material could be considered waste, and if there was a distinction it depended on whether it had resource value.

MARTIN: Before we go on to the reports of Working Groups II and III, a suggestion was handed to me that we don't need to have the report read since we each have a copy; thus, we should get right to the comments. Are there feelings on this?

UNIDENTIFIED SPEAKER: I agree with the panelist that we should do it right or not do it.

TODD JOSEPH (Working Group II): Jim, Group II will read its report very fast.

MARTIN: OK, we'll go ahead as planned.

WRITTEN COMMENTS

J. P. CORLEY [comment on Item B]: The consensus of Group I was not that the proposed criteria were unacceptable as a whole, but that they were inadequate; this is a real distinction.

WILLIAM A. LOCHSTET: Unwanted smoke detectors containing radioactive material (such as Americium-241) definitely are radioactive waste.

TOPIC II

WHAT ARE THE CHARACTERISTICS OF AN ADEQUATE
RISK ASSESSMENT AND OF ACCEPTABLE RISKS FROM
RADIOACTIVE WASTE?

RISK IN RADIOACTIVE WASTE MANAGEMENT: A STATEMENT OF ISSUES AND OBJECTIVES OF WORKING GROUP II

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Risk is an essential factor in the determination of environmental protection requirements for radioactive wastes. Considerable emphasis was given to this subject in our Background Report. Once a material has been designated a radioactive waste, risk, in our judgment, should be the primary determinant of how it is to be stored and disposed of. This precept raises two central issues: (1) What constitutes an adequate risk assessment to support choices between alternative storage and disposal technologies? (2) What are the principles according to which the acceptability, or alternatively the unacceptability, of any resulting risks should be determined?

WHAT IS RISK?

As used in our Background Report, "risk" is a general concept encompassing both the probabilities that certain events leading to adverse effects will occur and the health consequences should they occur. Various more specific representations of the concept have been discussed in technical literature, but they need not concern us here except to note that the concept can be extended to include some measure of the social value of the consequences.

WHY CONSIDER RISK?

The risks which concern us here are the health risks to current and future populations associated with the existence of radioactive wastes. Generally speaking, such risks cannot be eliminated entirely except by foregoing the benefits of the waste-producing processes. Risk is therefore one of the costs to consider in determining whether an activity provides a net benefit.

Risk is also the principal measure of the effectiveness of waste management systems, whose purpose is, after all, the limitation of risk. It is therefore a key factor in technological choice both before and after radioactive waste is produced.

It may be noted at this point that EPA's policy regarding the relationship of radiation dose and health effects is that, considering the current body of relevant scientific knowledge, it is prudent to assume that health effects are in proportion to dose, and that no threshold dose exists below which radiation exposure is totally safe. Until evidence indicates otherwise, this will be EPA's basis for estimating the consequences of radiation exposure for public health protection purposes.

WHY PERFORM RISK ASSESSMENTS?

A risk assessment for radioactive waste is an analysis of the potential adverse effects and the circumstances under which they might arise (see below).

Some of the reasons for performing a risk assessment have been discussed previously, and follow from the relationship between risk and technological choice. Some further reasons may be given, which, however, are not necessarily distinctly different from one another or those given previously:

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1. The performance of systematic risk assessment helps assure that decisions are made with knowledge of possible consequences. The process of performing the assessment also establishes a record which then can be independently examined for its technical adequacy and completeness.
2. Systematic risk assessment should help uncover aspects of a proposed waste management system for which reduction of uncertainty is desirable, or necessary.
3. Risk assessment illuminates the relationships between risks and control mechanisms, and should produce guidance for improved control technology.

It should be noted that in making these observations EPA does not intend that each individual possessor of radioactive waste necessarily should perform these analyses. The need to do so under given circumstances should be established in the regulatory process. The main objectives here are rather to determine EPA's own policies for radioactive waste, to govern its standard-setting and other functions, and also to provide guidance to other agencies with responsibility regarding such materials.

WHAT CONSTITUTES AN ADEQUATE RISK ASSESSMENT FOR RADIOACTIVE WASTE?

The working group should consider the adequacy of the following elements, which the EPA staff judges to be essential to a risk assessment for radioactive waste:

1. The assessment should consider the physical properties of the waste, including the quantity and types of radioactivity, the persistence of both the radioactivity and the form of the material, and the concentration of radionuclides. Generally speaking, these are necessary to broad characterization of the hazard potential of the material.
2. For each form and level of control mechanism the consequences of releases of the material should be examined, as a function of time. The word "releases" in this context refers to leakages and migrations of radionuclides, whether anticipated or not.
3. The probability of these releases occurring should be evaluated, as a function of time.
4. Consideration of the uncertainties in each aspect of the evaluation should be part of the assessment process.

To summarize, since the risk assessment is an analysis of the health hazard associated with a radioactive waste, any factors that characterize or contribute to the hazard should be included. To be most useful as a decision making tool, the uncertainties should be an explicit element of the assessment.

FOR HOW LONG INTO THE FUTURE SHOULD RISKS BE ASSESSED?

This issue has ethical, technical, and economic aspects. To the extent that risk assessment forms a basis for social and technical choice, it is possible that the time period over which the assessment is performed will significantly influence decisions.

Ethical Considerations

It is clear from the record established by our earlier Workshops that a wide diversity of opinion exists on the length of time into the future for which the current generation should be concerned about the potential environmental impacts of its radioactive waste. Moreover, those who believe in limiting consideration to a few hundred years or less are not necessarily motivated by selfish interests; the arguments supporting these views (which are reviewed in our Background Report) appear to us to be substantial. Nevertheless, EPA believes the most ethical and prudent position for it to adopt in the exercise of its public responsibility is to consider to the extent it can the consequences of its actions for all time. This position is in accord with the goal stated in the National Environmental Policy Act of 1969 (NEPA), to "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."

Technical Considerations

The assessment of health effects and other environmental impacts requires knowledge of populations, food chains, medical effectiveness, and uses of water, air, and mineral resources. On the basis of past experience, these data cannot be reliably predicted for more than a period of decades; educated guesses can perhaps be made for some hundreds of years, and beyond that estimations are increasingly speculative. There is therefore certainly an intrinsic, though not sharply defined, limitation on our ability to perform detailed assessments of future risks in a scientific fashion. Nevertheless, it may be argued that certain evaluations may be performed far into the future, if they are based upon only basic biological and physical facts.

Economic Considerations

One purpose of performing risk assessments is to examine the relationship between the incidence of health effects and other impacts and the means of control of the radioactive material. For long-lived materials, the longer the time for which we give consideration, the greater will be the risks and, presumably, the greater the justification for expenditure on additional controls. Thus a long-term view of risk may result in different choices than would result from a shorter-term consideration.

The conclusions we have tentatively reached, consistent with both the requirement of NEPA to use "practicable means" and with our own analysis, are the following:

1. Risk assessments should be performed as well as can be done to estimate health effects due to radioactive wastes for 1,000 years. This is not expected to yield unarguable scientific truth, but should provide a basis for comparison of technologies and judgment of impacts. Of course all assumptions should be fully described.
2. Even longer-term risks should be considered if they might substantially influence the choice of control systems.

HOW SHOULD ALLOWABLE RISKS TO FUTURE GENERATIONS RELATE TO RISK ALLOWED TO CURRENT POPULATIONS?

I have just presented our conclusion that risks for at least 1,000 years into the future should be considered in our waste management decisions. Now I wish to address the relationship we should adopt between allowable future and current levels of risk. Should our management objectives for radioactive waste be more or less stringent regarding

future impacts than we find to be acceptable for ourselves? Here again there are substantial arguments on both sides of the issue. It has been argued that future people are likely to be scientifically more advanced than we, with both improved remedial technology for inadequacies in our waste disposal and better medical interventions for any resulting health effects. Furthermore, the argument goes, since they are beneficiaries of our technical progress, it is fair for them to share in the risks. On the other hand, future people will have had no voice or choice in our technical and social decisions. Their preferences or needs for environmental purity may be less than or greater than our own. Given these substantial views supporting both more and less stringent standards for the future, EPA has tentatively concluded that its responsibility will be exercised if future impacts are at least as highly restricted as those allowed for current populations. Combined with our other criteria for environmental protection, this appears to us a fair principle, which should allow ample prerogatives to both current and future societies.

In practice this equity principle would imply, for example, that any waste management plan would be unacceptable which would lead to future levels of radiation in the general environment or in drinking water in excess of those allowed under current standards. Standards specifically addressing radioactive waste as a radiation source are currently under development at EPA, and these too will provide limitations on future risks at least as stringent as those on near-term risks.

HOW ARE WE TO DECIDE "HOW SAFE IS SAFE ENOUGH?"

The question "how safe is safe enough?" is so familiar as to have become trite, yet it expresses the profound concept that some risks may be worth taking. It should be noted, however, that we are concerned here with the methods and principles according to which agencies such as EPA should address the issue, and not with the answer itself. Of course our immediate goal is to lay a basis for development of standards and regulations for radioactive waste, but most of you will recognize that the underlying philosophical concepts are among the most important and characteristic issues of our time.

Some of the methods and approaches that have been suggested as a basis for determining acceptability of risks have been discussed in the Background Report. The subject cannot be fully discussed in the time available here, but I would like to summarize the scope of our analysis, and the conclusions.

We have examined the possibility of determining the acceptability of risks due to radioactive wastes solely by

1. reference to risk and benefit relationships established by past experience with activities and situations not directly involving radioactive waste (for example, it might be proposed that standards for disposal of radioactive waste should be set in some definite relation to past and current disposal practices for other industrial waste), or
2. comparison with risks due to natural background radiation, or with commonly understood risks not related to radiation (here for example, one might determine acceptable exposure levels for radioactive waste as being below some fraction of natural background radiation exposure), or
3. assessment of public attitudes and opinions.

We conclude that each of these methods contributes insight and perspective regarding the acceptability of risks due to radioactive waste, but no single approach satisfies all the logical and practical requirements to serve as a basis for setting public health protection standards. We therefore feel that the foundation does not now exist for a specific prescription according to which numerical standards may be developed independently of the specific circumstances which apply to a category of radioactive waste.

The absence of any single completely satisfactory procedure has not prevented and should not prevent effective regulation of radiation exposure. A framework for decision making has evolved in which the specific circumstances corresponding to each source of exposure are examined, and standards are then developed to assure that any allowed exposures are reasonable, under the circumstances. The guiding principles of this approach to radiation protection are

1. that any allowed exposures be associated with some justifying benefit,
2. that they be as low as is reasonable in view of technical, economic, and social considerations,
3. that inequitable distribution of risks be minimized, and
4. that certain stated levels of exposure of the general population not be exceeded, virtually without regard to circumstances.

We have concluded that this framework is adequate to guide the development of public health protection standards and regulations for radioactive wastes. To the extent that we have proposed significant new principles of public health protection for these materials, it is not because a new method of examination has been adopted, but rather that the established broad principles of radiation protection permit us to reach specific conclusions applicable to radioactive wastes.

WHAT RISKS ASSOCIATED WITH RADIOACTIVE WASTES ARE UNACCEPTABLE?

The principles of radiation protection require that exposures (or risks of exposure) be kept as low as is reasonable in view of technical, economic, and social considerations. Our Background Report and the other speakers present a survey of the characteristics of radioactive wastes, and certain broad considerations relating to their control. It appears to us, as a result of these considerations, that certain risks associated with the storage or disposal of radioactive wastes should be considered unacceptable, since they appear unreasonable in view of technical, economic, and social considerations. As an example consider a waste system where there would be a high probability of events that could result in acute effects, and this risk could not be reduced by reasonable controls. A waste system with these characteristics is unacceptable, in our view. Similarly, radioactive waste control systems are unacceptable if high-probability chronic risks are not at least as low as those that are socially acceptable under comparable circumstances. Furthermore, we feel that the probability of occurrence of events that could lead to high consequences should be lower for radioactive waste systems than is generally acceptable for productive technologies.

These conclusions follow from a broad examination of all radioactive wastes. EPA intends, through its standards development program, to examine each class of radioactive waste in detail and further define the risks to public health and the general environment which it considers unacceptable in view of the pertinent technical, economic, and social circumstances.

SUMMARY AND CONCLUSIONS OF WORKING GROUP II

INTRODUCTION

In the discussion below, the quoted items represent topics that were discussed rather than agreed-upon resolutions. Any consensus reached has been clearly marked as such, and the clear implication is that other assertions merely represent the views of some individual(s) within the group.

The management of existing wastes was discussed separately from that of prospective wastes. The following discussion of Items 1-8 applies to existing wastes.

ITEMS FOR DISCUSSION

Item 1: "Our responsibility to future people has no time limit."

It was the consensus of the group that our responsibility to future people has no time limit. Risk considerations are therefore necessary beyond the present generation. It was also expressed by members of the group that the responsibility to the future was not limited to future humans, but included responsibility to all forms of life.

Item 2: "An adequate risk assessment for radioactive wastes should estimate the potential health effects on humans for 1,000 years."

There was general agreement that the arbitrary selection of a 1,000-year risk assessment is not the correct approach. Several persons recommended that the population risk assessment should be carried out in time and distance until the risk to individuals in the population becomes statistically insignificant relative to natural background radiation or until uncertainties in risk estimates become too large for the estimates to be useful. Objection was made to the suggestion that there is any level of risk that is insignificant. Several persons expressed the opinion that the risk assessment should state the degree of uncertainty. There was disagreement as to whether the EPA should do risk assessment in the process of setting radioactive waste standards.

The question was raised, "Why is only human risk being considered when other elements of the biosphere could also be affected?" The EPA representative stated that it was EPA's decision that the human species is considered to be as sensitive to radiation as any other element in the biosphere and therefore the use of the human standard is justified. There was not a consensus agreement with the EPA decision. Other opinions were that the human species may not be the best indicator but that other biota, such as viruses, might be more sensitive to mutagenesis and to other effects of radiation on the entire life systems. It was also stated that humans should not be the only protected life form.

A suggestion was made that the EPA should be concentrating more on the development of acceptable criteria using deterministic methods (or past experience) rather than attempting to develop a probabilistic assessment to establish criteria. It was argued that such probabilistic assessment cannot be realistically done without specific data related to geologic data at the repository site and specific facility design information for the proposed repository, and that these analyses will be performed using deterministic (or past experience) or probabilistic methods at the time of the safety analysis report submittal prior to licensing hearings. A suggested starting point for EPA criteria determination was the existing radiation protection standards, 40 CFR 190.

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It was suggested that geologic uplift of locations for potential repositories after 1,000 years should be considered, and it was pointed out that the present Department of Energy (DOE) program was gathering data necessary to include such risks in the Safety Analysis Report risk assessment prior to construction licensing.

EPA's acceptance of the linear hypothesis as a basis for risk assessment was challenged by some members of the group who believe that there is a threshold level for radiation dose-response. Some people alluded to recent research suggesting that low levels of radiation exposure may be more dangerous than higher levels. A divergence of opinion existed as to whether the linear hypothesis was acceptable, nonconservative, or overly conservative. The consensus was that any standard selected would be subject to future change as future data became available. A question was raised as to which radiobiologists were to make that determination. EPA responded that they have a review team to evaluate radiation data; the discussion was inconclusive. It was suggested that EPA should clearly state the assumptions used with respect to the dose-response relationship.

A question was raised with respect to the methodology to be used in evaluating risk. Individual dose was suggested as an adequate measure of risk. Much discussion followed, and the following points were made:

1. Statistical risk to the total population should be included in the criteria.
2. The individual's probabilities should be multiplied by the total population to determine the population at risk.
3. The assessment should be done for the life of the radiation.
4. Probabilities of individual risk for the persons at risk should be aggregated over the total population to determine population risk.

It was also suggested that the individual should not be lost sight of in estimating statistical risks to whole populations.

There was disagreement and impasse on the methodology for evaluating risk statistically.

Item 3: "If consideration of adverse effects for a longer period might result in choosing a more effective disposal technique, then general estimates should be made for more than 1,000 years into the future."

There was general consensus that the arbitrary selection of a 1,000-year period was not the correct approach. There was also consensus that the meaningfulness of the analysis should be a determinant of the period for the analysis, but there was disagreement as to whether there was any level of risk that could be considered insignificant.

Item 4: "An adequate risk assessment should consider the quantity and persistence of the waste, and examine the projected effectiveness of alternative methods of control; an adequate risk assessment should also consider the probabilities of releases due to failures of controls and the uncertainties in all these evaluations."

In discussing risk assessment methodology for waste disposal the following sources were used:

1. the EPA Background Document,
2. criteria mentioned in Forum Agenda for Item 4 (above),
3. a resolution introduced from the floor stating that

"A risk assessment should

- a. be performed to such time as the risk to an individual becomes statistically insignificant or the uncertainties in risk make results meaningless,
- b. consider physical and chemical characteristics as well as quantities and persistence of waste,
- c. address mechanisms of local release of wastes from the repository and the likelihood of release,
- d. consider movement of radioactive wastes through the environment and the resultant human uptake, taking into account the effect of assumptions of future climate, land use, and demography,
- e. consider resultant health effects and assumptions of the relation of radiation dose to health effects,
- f. be as realistic as possible,
- g. estimate, to the extent possible, uncertainties in risk,
- h. identify processes and events which significantly contribute to either release of wastes or the human health consequences of release,
- i. identify those physical parameters which most influence risk and those parameters which have little effects on calculated risk."

It was stated that risk acceptability is a different concept from risk assessment methodology.

The discussion that followed resulted in these controversies, on which there was significant dichotomy:

1. It was debated who should perform the risk assessments. There was opposition to its performance by the NRC and private industry because of questions of credibility, accuracy, and past programs. It was questioned whether EPA has statutory authority for performance of risk assessments and whether risk assessments are appropriate to the development of criteria and standards. It was suggested that the risk assessment be performed by the National Academy of Sciences. It was also suggested that risk assessment should be performed only by persons who have undergone the experience of seeing a child die of leukemia.

2. It was questioned whose data and model of risk effects and probabilities will be and should be used in the risk assessments which are to be used in establishing waste disposal criteria. The assumption that statisticians as a class are necessarily objective was challenged.
3. Different opinions were voiced on how to contend with uncertainties surrounding risk assessments.
 - a. Some argued that we lack enough reliable data to perform a risk assessment with certainty, and therefore insisted on a moratorium on waste generation.
 - b. Others argued that, in view of the greater risk of exposed waste as opposed to buried waste, we should proceed with waste disposal, and that better criteria and methods will evolve, based on experience gained in the process.
 - c. The point was made that, as experience is gained, standards of safe exposure to radioactivity change.
4. It was questioned how we can ensure that all risks are included in a risk assessment that is based solely on calculations and judgment.
5. It was debated which alternatives should be included in a risk assessment. It was suggested that in order to expedite implementation of waste disposal only commercially available alternatives should be considered. In rebuttal one participant asked what we would do if none of the commercially available alternatives meet the established EPA criteria.
6. It was discussed how to consider or include the following important items having potentially large uncertainties as factors in risk assessment: human error, changes in weather, demography (including population size and land uses), and failure of engineered or environmental barriers. Quantity and persistence of nuclear materials was also discussed.

The following factors on risk assessment were agreed upon:

- A. The assessment should include a survey of public opinion, and dissemination of the result of the assessment to the public is desirable.
- B. Risk assessment must be performed as responsibly as possible.
- C. The elements of a risk assessment contained in the floor resolution were adopted as a consensus.*
- D. The necessity of performing a risk assessment for the transportation of radioactive wastes was adopted as a consensus item.

* Item A of the floor resolution was not a consensus opinion (see comment of William Lochstet, p. 50).

Item 5: "No prescription can be stated at this time for judging an adequate degree of protection for radioactive waste independent of circumstances."

Several individuals felt that this agenda item was unclear, but the proposition was vigorously defended by the EPA resource person. He justified the proposition on the ground that long discussions had led EPA to conclude that no single commonly used method of determining risk acceptability (i.e., solely by cost-benefit analysis, or by comparison with other technologies, or by means of polling public opinion) was by itself adequate for dealing with the problem of nuclear waste management, and that, therefore, a complex set of assessments involving all these factors needed to be undertaken.

Reactions from the floor included skepticism that others, after a full discussion, would agree that "no single prescription" could prove adequate. Two prescriptions were offered by individual participants as limiting statements that held up regardless of circumstance. One of these was that we could never accept a disposal system that might kill everybody, and the other was that human life was infinitely valuable and should be extended boundless protection.

It was suggested that an adequate degree of protection from radioactive waste should be zero exposure. Practically, if some release is allowable, there is then a pathway for release, which may lead to greater future releases. This should be proscribed.

Item 6: "Risks due to radioactive wastes should be unacceptable unless more complete isolation is unreasonable in view of technical, economic, and social considerations."

A portion of the group agreed with the EPA statement. It was suggested that this statement was to be a paraphrase of the ALARA ("as low as reasonably achievable") principle. It was criticized, on one hand, as offering only shifting ground to technologists, who, in the present waste crisis, need a clear and stable zone of acceptability at which to aim in their efforts to design a waste management system. On the other hand, this principle was condemned by several participants, first on the ground that the implied cost-benefit analysis was irrelevant as there were no benefits whatever from nuclear technology and, second, on the ground that economic considerations were totally inappropriate for determining the number of deaths from radiation exposure that might be acceptable. It was stated that, with enough money, scientists could provide a disposal system that would guarantee the safety of future generations. There was disagreement that this would be a proper allocation of taxpayers' or society's resources. It was strongly emphasized that actual human lives and not statistics were in question. It was argued that if vast resources were available for programs such as weapons and LMFBR, it was hypocritical to object to the proposal of a zero release criterion on the ground that resources were limited. There was considerable disagreement over this matter and the point was forcefully made by one member that the discussion was that of a life-life rather than a life-cost tradeoff. A comparison was made to emphasize the point that other energy technologies (e.g., coal) also had risks and these risks should be used to place a perspective on nuclear waste risks. There was mixed response to this comparison, and several members considered it invalid. They expressed the belief that any technological risk to human life was unacceptable, and one opinion was that the use of coal could be made clean and safe. Others concurred that the safest total package (comparative risk) should be used. One person argued that since even when perfect isolation is promised (e.g., in the case of Lyons, Kansas) perfect isolation may not occur, we must not settle for less than perfect containment as a goal. No consensus was reached.

A portion of the group maintained that zero risk should be a goal, while another part of the group felt that mitigating factors (social, economic, and technical) needed to be considered (e.g., that the disposal of waste underground even with less than perfect containment was better than the current situation). Some participants also felt that zero risk was unattainable.

Item 7: "Risks to future generations due to our radioactive waste should be no greater than those accepted by the current generation (as expressed in its standards and regulations for radioactive waste)."

There was consensus that risks to future generations due to our radioactive waste should be no greater than those accepted by the current generation. However, there was a strong division between the following two points of view:

- a. Future generations are not the beneficiaries of the waste-producing activities and have no voice in the matter. Those holding this view believed that risks to future generations should definitely be less. Many holding this view felt that the risk to future generations should be zero. Some also felt that the use of the word "beneficiary" was inappropriate on the grounds that existing wastes have no benefit.
- b. Future generations inherit the technology developed by the present one, and thus are beneficiaries of the waste-producing activities. Those holding this view believed that it is therefore reasonable that future generations share the risk. This concept of "equity" was proposed as being implementable considering future uncertainties and that there is a societal and cultural continuum. Some felt that waste resulted from past and continuing activities which do have social benefit.

Other points made included the following:

It was urged that the concept of equity apply not only for future generations but also for all segments of the population in the present generation, and that the populations of certain geographical locales not be asked to shoulder a disproportionate burden. The question of "consent" was also raised in relation to the rights of states and citizens to determine whether or not to accept radioactive wastes for disposal and the need for uniform enforcement of such criteria as are determined.

It was suggested that EPA apply consistent criteria to nonradioactive hazardous wastes and to radioactive waste to achieve equity in regulation. On the other hand, it was suggested that there be special consideration for radioactive material.

Item 8: "Certain risks due to radioactive waste should be considered unacceptable. These would be associated with circumstances in which

- a. any exposure having a high probability of occurrence could result in more than a chronic risk which could not be further reduced by reasonable controls,
- b. the levels of any chronic risks are not less than those for comparable high-probability circumstances acceptable to society, or

- c. high-consequence events do not have a probability of occurrence less than that for comparable high-consequence events accepted by society for similar productive technologies."

During the discussion of these questions, a general feeling emerged that the wording was confusing. However, no substitute wording was generally agreed upon.

- a. There was little dispute that the risk due to radioactive waste would be considered unacceptable if there were a high probability of exposure resulting in more than a chronic risk that could not be further reduced by reasonable controls. Opposition to this statement was on the grounds that it was too ambiguous.

Two other points were discussed, and no consensus was reached. As suggested by the EPA, these points were the following:

- b. Levels of chronic risk would be unacceptable if they were not less than those for comparable high-probability circumstances acceptable to society.
- c. Risks associated with events having high consequences would be unacceptable unless the probability of such events was less than the probability of comparable high-consequence events accepted by society for similar productive technologies.

Divisions of opinion with respect to questions b and c were basically similar. Three points of view were fairly widely held:

- 1. Some participants felt that risks from radioactive wastes should be less than other comparable risks.
- 2. Some members felt that the risks for radioactive wastes should not be required to be less than comparable risks; they should only be considered unacceptable if they are greater.
- 3. Some felt that risks from radioactive wastes are unique and that therefore there is no such thing as a "comparable" or "similar" risk.

A number of other ideas were mentioned, including the following:

- 1. There was disagreement with the term "acceptable to society" because it implies consent, where none has been given with respect to radioactive waste.
- 2. In judging acceptability, the risks due to radioactive wastes should be compared with the risks of other activities having a social benefit comparable to the benefits of the waste-producing activities.
- 3. Wastes should not be subjected to especially severe restrictions on the grounds that they have no benefit associated with them; instead, they should be judged in the context of the benefits of the waste-producing activities.

DISCUSSION OF PROSPECTIVE WASTES

The management of prospective wastes was discussed separately from that of existing wastes. This discussion focused on risk and risk acceptability from disposal of prospective radioactive wastes, including low-level, medical, and high-level wastes. Points considered were the following:

1. In developing and applying risk acceptability criteria, should existing and prospective radioactive wastes be considered independently?
2. How should the determination of risk acceptability and the assessment differ? (It may be appropriate to review Items 1-8).

A. Risk Acceptability

Some members of the group believed that the existing and prospective risks from radioactive wastes should be treated the same; however, costs for waste management could be different for each.

Other members of the group, while desiring to keep the existing wastes under as strict a control as possible, were not willing to accept any risks from future radioactive wastes and called for a moratorium. Some suggested zero release; others said zero release is not possible.

There were two viewpoints on the adequacy of existing technology for safe disposal of high-level radioactive wastes. Quotations from the California Energy Resources Conservation and Development Commission draft report on High Level Waste Disposal and a letter from the Director of the Executive Office of Science and Technology Policy supported the view that an adequate scientific data base for geologic disposal does not exist at present; however, a report to the American Physical Society by the study group on nuclear fuel cycles and waste management in the January 1978 issue of *Reviews of Modern Physics* (Vol. 50, No. 1, Part II) disagreed (see Appendix following this summary).

There was concern expressed that the present status of existing wastes is dangerous and that the waste disposal management program should address that problem. However, there should be no compromise in establishing regulations for future waste, and these regulations should be as strict as necessary to protect public health. Indeed, future standards should be determined by public discussion to quantify what is an acceptable risk.

It was pointed out that if one is to accept the position of zero release of radioactive wastes from the nuclear fuel cycle, then one should also be willing to require a similar strict control of hazards from other sources presenting radiation risks (e.g., coal, geothermal, x rays, phosphates).

Another member argued that the risks from stored wastes will be influenced by the amount of Congressional funding that would be available for the management of radioactive wastes.

The issue of voluntary versus involuntary risk was raised. With respect to risks from future wastes, it was pointed out that unborn populations would be denied the constitutional right to choose that risk.

B. Cost of Waste Disposal

A side issue discussed by members of the group dealt with assessments of cost for waste disposal. Some felt that the costs should be paid by the beneficiaries, namely the present generation. Others shifted the burden of cost to the utility owners. Some suggested that costs may be higher for present wastes than for future wastes because of the potential different form of future wastes. Some insisted that the cost of disposal was not an issue and that wastes should be disposed of safely regardless of cost.

C. Philosophic and Moral Discussions

Alternative power sources were briefly discussed. It was suggested that future technologies might have more difficult or hazardous waste disposal problems. When the risks from coal were raised, it was pointed out that the technology exists to clean up the effluents from coal-fired plants and that the health effects from mill tailings outweigh the effects from coal-fired plants. There was disagreement on the extent of the relative risks in comparing coal with nuclear power. It was also pointed out that other power generation technologies also have health risks.

A fair basis on which EPA should derive acceptable risk standards for electricity generation should be per unit of electricity generated, independent of the method of generation.

Several moral issues were raised:

"We must turn away from a nuclear future... reliance on nuclear technologies or weapons [is] an arrogance to the earth. Indeed, any planned release is premeditated murder."

"There should be a moratorium on the future generation of radioactive wastes until acceptable storage solutions are proved safe and publicly accepted."

The issue was raised that the lack of generation of power and the consumption of nonrecoverable fossil fuels are also moral issues, because the effects on people may be much more damaging than the risks associated with the nuclear-fueled generation of electric power.

"Regarding public health risks--one case of leukemia is one too many."

"There should be greater public education, such as town meetings, in order to increase public discussion of risks versus benefits associated with nuclear technologies, and to allow the public to choose whether or not to license individual nuclear plants."

APPENDIX

The geologic and hydrogeologic conditions that can provide for satisfactory isolation of radioactive waste exist in enough places that we anticipate no difficulty in locating several suitable sites in different geologic media within the immediate future.(1)

Current knowledge and technology are adequate to design and locate a suitable waste repository of the conventional mined type, if utilized with appropriate site selection criteria.(1)

Since geology is not a predictive science, it may not be possible to reduce the uncertainties inherent in geologic disposal to a level where there is a high degree of confidence that the wastes can be confined for 100,000's of years. In conclusion, if we proceed with geologic disposal on the basis of technical optimism in the face of scientific uncertainty, then we are no better off than having the waste in an engineered surface facility and we will have to maintain the same perpetual surveillance by mankind of the repository (which in concept should not require it).(2)

Nonetheless, [the Analysis of the Back End of the Nuclear Fuel Cycle with Emphasis on High-Level Waste Management] has identified some areas where problems are seen to persist. As given in the report's summary, these include:

...(6) a lack of an adequate scientific data base for the geologic storage of nuclear wastes.

I feel strongly that adequate resolution of the political, institutional and remaining technical problems is crucial to public acceptance of the government's waste management plans and to the success of the nuclear component of the President's energy program. We have a collective responsibility to work with DOE, EPA and CEQ to assure the success of the waste management program.

Signed, Frank Press, Director (3)

WORKING GROUP II PRESENTATION COMMITTEE

Name	Affiliation
Albert Bates	Catfish Alliance, Tennessee
William S. Brown	Westinghouse Electric Corporation
Debby Browne	Greenpeace Foundation
Marc W. Goldsmith	Energy Research Group, Inc.
Judy Hurley	Cactus Alliance
J. W. Lentsch	Portland General Electric Company
W. A. Lochstet	Pennsylvania State University
Henry Morton	Nuclear Safety Associates
Neil Norman	Bechtel National, Inc.
Alexis Parks	(writer)
Christopher Taaffe	Boulder Mobilization for Survival
David C. Williams	Americans for Rational Energy Alternatives

(1) From Reviews of Modern Physics 50 (No. 1, Part II) (1978).

(2) California Energy Resources Conservation and Development Commission report on high-level waste disposal.

(3) Executive office of the President, Office of Science and Technology Policy, letter dated 3 November 1977.

RESPONSES OF FORUM PARTICIPANTS TO SUMMARY
AND CONCLUSIONS OF WORKING GROUP II

Second Plenary Session

HENRY MORTON (Nuclear Safety Associates, Bethesda, Maryland) [comment on Item 5]: EPA resource persons stated that the EPA has already concluded that Item 5 is correct and strongly defended it. It is inappropriate and is a sham for the EPA to include such an item in the agenda on which it has already drawn a conclusion.

JUDY WILKINSON (Boulder Mobilization for Survival): What agreements were made about how to develop an adequate data base when scientists are silenced by the industry?

MARC GOLDSMITH (panelist): I don't know that that's something that we can respond to.

TODD JOSEPH (moderator): I don't think that the topic was discussed, except for the references made to...some argued that we lack enough reliable data to perform a risk assessment successfully, and insisted on a moratorium on [inaudible]. Others argued that, in view of the greater risk with exposed waste as opposed to buried waste, we should proceed with waste disposal, and that better criteria must be evolved through experiences gained in the process...

ED HARTOWICZ (Dames & Moore, Lexington, Kentucky): Risk assessments are couched in terms of direct health risks to humans. Should there not also be included those additive risks to agricultural productivity, impact on the economy, and loss of habitable areas where ground water contamination would preclude the use of the water for irrigation or consumption?

KATHRYN PARTRIDGE: My basic questions and comments are included in the Fourth Report, which we were not allowed to read before the body and tape recorders. I would like to emphasize the non-democratic way the proceeding was held, calling for many more hearings in more accessible locations (to the general public). This session cannot be considered an adequate forum reflecting public opinion. Many key issues were not adequately addressed by the formation of a rather strict agenda in Group II. The central question of whether nuclear industries can be allowed to continue was not allowed an adequate debate. However, I must applaud the EPA for this step in the right direction toward true citizen input in the decisions which mortally affect them.

Items 3 and 4 of the Risk Assessment summary [do not] include comments I made that risk assessment must be carried farther into the future than "statistically significant" and/or "containing uncertainties." The analysis should be carried out to the lifetime of the radioactivity, with uncertainties in data and standard deviations and other statistical variations clearly stated. It should be publicly decided at which point these figures become meaningless.

BEN BILLINGS (Environmental Action of Colorado, Denver): Thirty-five years have elapsed since the birth of the nuclear age. In that time, there has never been a governmentally sponsored forum to discuss the social, ethical, and/or human acceptability of nuclear power. Discussions of basic acceptability are always ruled "out of order" at public meetings. It was pointed out many times at this meeting that this is "not the proper forum" for such discussions. I urge that the "proper forum" be created to foster full discussion of the basics. Thousands of meetings, discussions, presentations

need to be held in all parts of the country, so that the American people, regardless of where they live, can participate, be heard, and decide.

COMMENT (name withheld): The EPA should soon, or next, address itself to the question of the safe operation of nuclear power plants and weapons facilities, using the standards of acceptable risks that will have by then been formulated in a way that takes into account all implications of the operation of these facilities.

ARTHUR J. SOINSKI (Energy Resources, Conservation, and Development Commission, Sacramento, California) [question on Item 3]: Please define "life of radiation."

GOLDSMITH: I don't think we discussed the technical details of half-life or life of radiation. I think there is an indication in the toxicity for time and for long half-lives of time that the waste must be kept isolated, but we did not discuss technical definitions about life of radiation.

CARL J. JOHNSON (Jefferson County Health Dept., Lakewood, Colorado): Who are the members of the EPA review team that will evaluate radiation data, and have they been associated with the Atomic Energy Commission, the Nuclear Regulatory Commission, or with nuclear industry or large university projects funded by AEC?

JOSEPH: The review team that is referred to is a committee of the National Academy of Sciences, the BEIR Committee, and is not an EPA body as such.

JOHNSON: I apologize for my writing... The last part of that question was "...with nuclear-related industry or with large research projects in universities funded by the AEC." The reason for this question, and this may still apply to the BEIR Committee (I'm not really certain), is that it is my opinion that persons who have worked with the AEC or with the industry, or who have worked with university projects whose life depends on funding by the AEC (of course, now the Department of Energy) really have some at least unconscious bias in favor of less conservative standards. I feel strongly about this. I don't feel you've answered my question.

JOSEPH: We understand the implication of your question, and I think we answered it.

JOHNSON: Thank you.

"JOHN GALT" [pseudonym]: What in life, from childbirth to living in a quiet little town like Waverly, Tennessee, has zero risk or a certainty about the future? Has the American citizenry been reduced to a point where its own personal safety is placed above higher goals such as political freedom and economic responsibility, i.e. paying one's way through life instead of living off the efforts of others? Would you ask any of the anti-nuclear participants who are perfect to stand up and define "perfect containment?"

DAVID C. WILLIAMS (Americans for Rational Energy Alternatives, Albuquerque, New Mexico): It was pointed out during this group's discussion of Item 2 that risk assessments should prove useful even if relative uncertainties are large, provided it can be shown that the risk is less than some upper limit value which is itself sufficiently small to be acceptable. The group's drafting committee omitted this observation in its report.

ANDREW SNOW: I feel saddened by the fact that much of the basically humanitarian inputs expressed by the environmentalists present at these meetings will be suppressed by the strength of the corporate interests, especially through behind-the-scenes finagling. Only when we come to a realization as a society that economic interests must

come second to concerns for our health and the health of our descendents are we ever going to be able to create a chance for our species' survival. That's the key. Survival... I find it very hard to swallow that many of my contemporaries don't care about leaving deadly nuclear waste time bombs for our unsuspecting descendents, if we are lucky enough to have any.

JOHNSON: Why not reference radiation protection guides on the 4-millirem annual dosage limit to any organ or total body established by the 1976 EPA Drinking Water Regulations?

JOSEPH: Well, again, I'm not sure that's a question about what the report says...is it a general suggestion?

JOHNSON: Perhaps it should be taken as a comment or suggestion rather than a question... I think the 4-millirem standard is well supported by the EPA's Support Document, and I think that it might be a good reference point for standards for radiation exposure from other environmental sources.

ROWE: One point of clarification: That is only for drinking water.

JOHNSON: The regulation does apply to drinking water. There's a separate section, however, of the standard which relates to exposure to radium and manmade beta and photon emitters and water, and I think that the importance of this regulation is that it's well-researched [and] well-supported and applies to one source of environmental exposure. I think it's very relevant to the question here today. Thank you.

CHRIS TAAFE: A cost-benefit analysis, in its broadest sense, lies close to the heart of this matter of establishing risk acceptability. My opinion is that no risk is acceptable. For some reason, although costs were addressed, no probing exploration of the nature of the benefits claimed was conducted. My question is: What are the real benefits of nuclear power--and don't most of them actually accrue to corporations inequitably as enormous profits at the expense of the health and emotional security of people today, their children, and the children of future generations?

COMMENT (name withheld): Risk from radioactive wastes are indeed different from other high toxicity wastes. Radioactivity decreases with time while others, such as arsenic, lead, many carcinogens do not diminish. This involuntary risk is assigned by our society to future generations as a by-product of society on the basis of a de facto cost/benefit assessment.

STEVE DAVIS: The EPA should choose a location for its future public forums where the freedoms of speech and assembly are allowed to be adequately expressed. Some members of this conference were once threatened with arrest, when peacefully presenting their views. This occurrence happened the first day of the conference, and I was one of them that was threatened, and believe me, it's a very bad way to start out a conference.

DR. JAMES MARTIN (Chairman): I can't let this one rest. The hotel approached us after (whatever this event was) as to whether or not they should preclude this, and we said, "No, these people are here, they're part of the public, they have a right to do whatever they wish, and unless they somehow endanger your property or your resources here...If you take any action, it's on your own, not on behalf of this agency."

COMMENT FROM AUDIENCE: What were they doing?

MARTIN: I frankly don't know; it didn't interest me.

ALEXIS PARKS (panelist): It was a street demonstration out in front of the hotel...is there a better definition of it? All right, demonstration is the wrong word, it was just...there were several people involved.

JOSEPH: The point of the matter is that, when the question was brought to EPA, the hotel was instructed that we did not wish to preclude any such demonstration.

MIKE RAUDENBUSH: It seems to me that the Group II report was an adversary report--pro-nuclear side, anti-nuclear side, pro, anti--and I compare that with the Group I report, in which, although there [wer] plenty of adversary positions expressed, there was some kind of a consensus that came out of that group, with minority views. I would simply suggest to EPA that, from my point of view, the smaller the group discussing the subject the better, and that for future meetings you might try to break up into smaller groups to avoid this kind of "I'm right"/"No, you're not."

DR. WILLIAM HARDING (Drexel University): The EPA should explicitly point out in any public document that people in fact make cost-risk and/or risk-benefit decisions inherently in their daily lives though they may not be aware of this reality.

JUDITH HURLEY (Boulder Mobilization for Survival, Cactus Alliance): The failure to thoroughly review the nuclear weapons industry as a source of hazardous nuclear materials was an overwhelmingly serious limitation on the meaningfulness of these discussions. While I'm up here, I would like to explain also what the "offensive" street theater was that got the police down on us. We had a 6-foot globe, that's all--a 6-foot earth--as a symbol of what these discussions were about, and the police said that unless we got this representation of the earth off of hotel property we would be immediately arrested.

STEPHANIE J. BAKER (Western Nuclear, Inc., Denver, Colorado): A basic premise of our free society is that continued industrial development is compatible with appropriate control of radioactive wastes. To suggest a moratorium on nuclear power development until the radwaste issue is resolved is absurd.

WILLIAM A. LOCHSTET (rapporteur, Working Group II): In Item 4 of the Report under Factors on Risk Assessment[the following point was agreed upon: Item C might imply an endorsement of the entire floor resolution. The elements of risk assessment contained there in Items B,C,D,E,F,G,H,I were generally agreed to. However, Item A of the floor resolution was not endorsed, as is clearly indicated elsewhere in the Group II report, particularly as appears under Item 2. The self-contradiction was not deliberate.

CAROLYN LANDES [comment on Item 7(b): The question of passing on the nuclear technology and all the risks involved with it cannot be related to the general premise that future generations inherit the technology developed by the present one. Nuclear energy has been proven to be more destructive than any other technology man has developed. It's hard for me to consider (b) as a valid argument for it being reasonable to expect future generations to share the risk. Passing on a nuclear technology feels very different to me than passing on a solar technology.

PAUL BURMEISTER (Mid-American Coalition for Energy Alternatives) [comment on Item 4, part 3 (h): I feel that it is important that the EPA always consider the risks of possible human intrusion[or] any proposed terrestrial radioactive waste repository in such activities as drilling or mining sometime in the future, which could damage the

geological integrity of the repository, leading to possible exposure of the waste to the biosphere.

WRITTEN COMMENTS

LOCHSTET: Item 2 stated that an adequate risk assessment should estimate the potential health effects for 1,000 years. I would not consider a risk assessment adequate unless it estimated the potential health effects on humans for much more than 1,000 years, preferably millions of years.

TOPIC III

WHAT CONTROL MEASURES SHOULD BE UNDERTAKEN FOR RADIOACTIVE WASTES?

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CONTROL MEASURES FOR RADIOACTIVE WASTE: A STATEMENT OF ISSUES AND OBJECTIVES OF WORKING GROUP III

Joseph E. Fitzgerald, Jr.
Waste Environmental Standards Program
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INTRODUCTION

The purpose of this presentation is to provide a perspective on the proposed criteria as they relate to requirements for control of radioactive wastes. The goal of radioactive waste control was deliberated at the Workshops in Reston, Virginia, and Albuquerque, New Mexico, and by EPA both within and outside the Agency. Notwithstanding some reservations, a general consensus exists, we believe, that the goal of control should be to isolate radioactive wastes from the biosphere over their hazardous lifetime. This goal should be pursued not only to prevent adverse effects on humans, but also to prevent long-term environmental contamination. In pursuit of such a generalized goal, there are a number of specific controls, existing and proposed, for various wastes. They basically involve either institutional approaches or isolation by environmental barriers. The balance of this presentation deals with judgments pertaining to acceptable types and degrees of control via these approaches.

INSTITUTIONAL CONTROLS

A judgment was reached from our past two Workshops and subsequent deliberations within EPA that, recognizing the increasing uncertainties associated with institutional continuity over time, there is a need to establish a limit to our planned reliance on institutional control. Given the perspectives of human, institutional, and environmental time scales, and the "relative predictability" of events over these time frames, it was our judgment that 100 years represents an appropriately conservative figure. It should be emphasized, though, that this does not purport to suggest how long these institutions may actually survive; only how long any form of control for radioactive wastes should depend on them.

While a numerical criterion such as this one carries with it some rather obvious implications for current and proposed management practice, there are other, perhaps less recognized implications that bear on the acceptability of institutional control. To a large extent, these involve institution-related measures which may offer net advantages in safety beyond 100 years. Examples are monitoring, retrievability, and passive communication using records or markers. In terms of long-term environmental isolation of wastes, serious questions have been raised as to the effectiveness of these measures and whether any reliance on them is acceptable. It is clear that it is difficult to design for retrievability or conduct a monitoring program without compromising isolation to some degree. Likewise, passive communication cannot be relied on over the long term, and may, in fact, prove detrimental if the presence of such a record improves the probability that site intrusion will take place.

On the other hand, it is also recognized that, given certain circumstances and limitations, these provisions may enhance the overall protection from the wastes. One such limitation is the 100-year institutional control limitation proposed by EPA, which would make longer reliance on any of these measures unacceptable. For passive communication, however, reliance on institutions would not necessarily be required. Likewise, a designed capability for waste retrieval or postoperational monitoring would be acceptable with the caveat that safety is not to be compromised, which represents a

second restriction. In this regard, if monitoring activities, designed retrieval, or even the placement of markers could decrease waste isolation now or in the distant future, application of these measures should not be allowed since no net improvement would be expected in environmental and public health protection.

ENVIRONMENTAL CONTROLS

In contrast to institutional controls, environmental controls entail the use of natural and/or engineered barriers to ensure isolation. As commonly applied, the main barrier is the geological medium in which the waste is interred. These media are chosen because of their physical properties, which inhibit the movement of waste both physically and chemically. They are normally supplemented with engineered barriers, such as containers or the form in which the waste is managed. Despite the fact that some engineered barriers have survived intact over time, others of like design have not. Since the primary consideration for waste management is reliable isolation, it is our conclusion that engineered controls should only be depended upon for interim institutional management or for use in conjunction with natural barriers.

In ensuring the acceptability of environmental barriers, proper site selection is important in maintaining protection of the materials over the time periods in question. On this basis, then, it would seem prudent to select environs where stability would be enhanced, not decreased, by the effects of natural forces, such as erosion, sedimentation, and crystallization. For example, a pile of radioactive low-level diffuse waste would probably be better "disposed of" in an abandoned open pit mine than left exposed to the natural elements of the surface. In this case, earth cover would be expected to increase with time and would be more desirable. We have therefore concluded in the criteria that, all other safety factors being equal, disposal sites should be chosen which would have a long-term positive effect on isolation.

RADIOACTIVE WASTE CATEGORIES AND CONTROL: CURRENT AND PROPOSED PRACTICE

The various categories of radioactive waste and their respective characteristics and magnitudes have been described in the first presentation. A similar overview would be appropriate to put the available control options into like perspective. Waste management alternatives can be broadly classed into three categories:

1. generally accepted alternatives based on existing technology,
2. currently unacceptable alternatives based on existing technology,
3. concepts based on future technological developments.

The first group includes control concepts and methodologies that require state-of-the-art technology for implementation, although the concepts themselves may be unproven. For example, deep geological disposal requires the selection of a suitable geological formation whose characteristics ensure the isolation of the disposed waste. While the disposal technology is largely defined, much of the research is currently centered on the selection process. Current candidates receiving attention in this country and elsewhere are rock salt, as found in both bedded and dome formations, argillaceous (clay) formations, and various hard rock formations (granite, basalt, and limestone, to cite a few). All of these formations have physical characteristics which minimize the possibility of release via groundwater intrusion, the primary potential pathway. Almost all of the current practical knowledge of radioactive waste disposal derives from

experience with shallow land burial. There are presently four active and two inactive commercial burial sites in the United States. The wastes disposed in them, although made up of predominantly short-lived fission products, also contain a fairly broad cross-section of radionuclides with significantly longer half-lives and higher radiotoxicity (e.g., radium-226 and transuranics). Operating experience at a number of burial sites in this country has shown that, in some cases, actual contact between the waste and ground water has occurred, with detectable contamination monitored off-site. In contrast to deep geological disposal, proper isolation as defined for this methodology is almost entirely dependent on institutional management.

The second group of control practices covers state-of-the-art management concepts whose acceptability is in question, such as ocean and terrestrial dispersion. These two techniques make use of the "dilute and disperse" principle, which we judge not to be an appropriate solution for the disposal of radioactive waste. Ocean dumping (as opposed to deep seabed disposal) has been employed by this country in the past and is currently being used by a number of foreign countries. There is, however, concern over maintaining acceptable isolation of wastes interred in this matter.

The third group of control alternatives encompasses technologies which have yet to be developed. These include such techniques as deep space disposal, ice cap disposal, and waste partitioning and subsequent isotopic transmutation. It is clear that some of these may offer advantages over methods that are available for immediate use. We are paying particular heed, though, to the views repeatedly emphasized in the workshops and other similar forums that it is the responsibility of this generation to pursue options which offer solutions for the near term, as opposed to creating a further legacy of our waste management problem.

With regard to existing control technologies, therefore, the degree to which particular control options are applicable is dependent on the characteristics of the waste to be managed. High-activity long-lived waste includes what traditionally is called high-level waste, meaning reactor fission products as well as unprocessed spent fuel. It also encompasses discarded medical and industrial sources which meet the criterion of being capable of producing radiation exposures with immediate, or acute, effects. These wastes, because of the nature of the hazard they represent, need to be completely isolated from the biosphere for the extent of their hazard. The degree of control necessary to ensure acceptable isolation is dependent on the effectiveness of a number of engineered and natural barriers. These include the form of the waste, use of suitable containers, the integrity of the geological formation, and the retardation of waste migration within the medium itself. Because the half-lives of the critical nuclides are typically hundreds to thousands of years, disposal is being proposed in deep geological formations whose stability will conceivably outlast the hazard.

For high-activity waste whose hazards are relatively short-lived, acceptable isolation would require a combination of institutional and environmental barriers of sufficient duration to ensure acceptable control over the period in question. For wastes whose recognized hazard would exceed 100 years, reliance on institutions of any kind would not be justifiable on the basis of the EPA criterion proposed. Present practices for disposing of some of these wastes by shallow land burial, therefore, may need to be modified, in particular by restricting disposal of certain materials by this method.

Few control techniques are available for low-activity long-lived wastes, and those that exist are not completely acceptable. Because of the characteristics of the waste involved, the associated hazard is chronic, entailing a relatively small degree of control over an extended period of time. Of the two forms of wastes in this category, discrete

and diffuse, acceptable control of the latter has proved to be particularly difficult to resolve. Sometimes termed "naturally occurring diffuse waste," they include materials such as uranium mill tailings and phosphate wastes, whose large volumes make conventional management impractical. Currently, these wastes are stored on or very near the surface, with initial but nonuniform stabilization and/or reclamation being performed. With the proposed restriction on institutional reliance, though, stabilization as now practiced could prove to be unacceptable.

SUMMARY

To summarize, there are two available means of control for radioactive waste management: institutional and environmental. For institutional management, EPA has proposed a 100-year limitation on reliance. In this regard, no restrictions on customary uses of land areas and surface and ground waters due to residual waste hazard can be permitted. This criterion would therefore be of consequence with regard to current shallow-burial and surface-storage modes of management. Other institutional management provisions, such as monitoring, retrievability, and passive communication, would be acceptable if they satisfied all of the EPA criteria and if a net improvement in safety could be shown.

With regard to environmental control, proper site selection is a primary consideration. Whenever practicable, locations for radioactive waste disposal should be chosen such that the effect of natural forces such as erosion and sedimentation is positive. For waste isolation in geological media, sites should be chosen to reduce the effect of potential interaction of the waste with ground water to the greatest extent possible.

SUMMARY AND CONCLUSIONS OF WORKING GROUP III

At the initial evening meeting of Working Group III, organizational and agenda questions dominated the deliberation. The suggested questions prepared by EPA were discussed, and several additional questions relative to the proposed control criteria were added (see asterisked questions in Attachment 1). These questions were then used as the basis for the discussion on the proposed control criteria presented in the EPA Background Report. The issue of using 1,000 years in the cost-benefit analysis was questioned and strongly criticized. Bill Rowe of EPA stated that the figure was a "straw man" and was intended to elicit comment from the group. There was also extensive discussion at this initial meeting that centered around clarification and/or definition of such terms as reliability, predictability, and effectiveness. The need for clarification and definition were the bases for including additional questions on the proposed list.

Even though EPA expressed the opinion that this was "A Public Forum on Environmental Protection Criteria for Radioactive Waste," there were questions from the group as to its adequacy in this regard. The validity of relative hazard indices was discussed without resolution, as were questions of reimbursement for property cases and incentives to communities to accept waste repository siting. The question of the proper role of control criteria in specifying a release probability was raised, but was not addressed by the group.

An opinion was expressed that the entire Forum was predicated on the acceptance of a nuclear economy. One individual wished to enter into the record his strong disagreement with such a premise. This item was not discussed by the group.

The second day of deliberation was devoted to criteria proposed in the Background Report. These criteria were written as follows:

4. Controls should be applied with a goal of isolating radioactive wastes from the biosphere over their hazardous lifetime to protect humans and minimize unnecessary contamination of the environment. When institutional control is the method chosen to provide environmental protection of radioactive wastes, no restrictions on customary uses of associated land areas and surface and ground waters due to any residual risks should be required after 100 years; radioactive wastes that would require protection beyond 100 years should not be isolated by institutional means, but rather by as many physical and natural barriers as is practicable to minimize environmental impact if one or more fails or is accidentally or intentionally breached.
5. Locations for radioactive waste disposal should be chosen whenever practicable such that the action over time of natural forces such as erosion, sedimentation, and crystallization could be projected to improve, rather than reduce, environmental isolation; if used to isolate wastes, geological media should reduce the effect of potential interaction of the waste with water to the greatest extent possible.
6. Certain additional procedures and techniques should also be applied to waste disposal systems which otherwise satisfy these criteria if they provide a net improvement in environmental and public health protection; among these are:
 - a. monitoring prior to completion of disposal to determine for timely correction any unanticipated effects which could result in releases of radioactivity to the general environment,

- b. procedures or techniques designed to enhance the retrievability of the waste, and
- c. passive methods of communicating to future people the potential hazards which could result from an accidental or intentional disturbance of radioactive wastes.

DISCUSSION OF CRITERION 4

Discussion of Criterion 4 revealed the problems of various group members with terms such as "unnecessary," institutional control," "ground waters" (in the general sense), "100 years," "physical," "natural," "practicable," and "minimize." It was also pointed out that there was no mention of cost-benefit analysis or cost-effectiveness in the criteria. The word "unnecessary" was felt to be somewhat subjective and superfluous, and the group recommended that it be deleted. Further, it was felt that the word "continuously" should be added to make it clear that controls should apply from the time when the material is defined as waste, including transportation and handling.

The group did not agree with the definition of "institutional controls." The problem with the original definition derived from the feeling that "devices" were not properly part of institutional controls. Accordingly, it was recommended that the definition be changed to

Institutional controls—Activities that involve the performance of functions by human beings to limit contact between the waste and the human environment.

The group felt that 100 years was too arbitrary a length of time to predictably rely on institutional controls. Accordingly, the consensus was that it should not be included in the criteria. There was also some discussion on the advisability of using historical precedents as a basis for predicting the reliability of institutional controls.

The words "physical" and "natural" were used in such a way as to imply that natural could not be physical and vice versa. The group thought this was an obvious error and that "physical" should be replaced by "engineered."

The group recommended that Criterion 4 be reworded accordingly:

Controls should be continuously applied with a goal of isolating radioactive waste from the biosphere over their hazardous lifetime to protect humans and minimize contamination of the environment. Reliance on institutional controls should be minimized; primary reliance should be placed on engineered and natural barriers to protect the environment and public health. It is recognized that such actions as operational controls during disposal operation, temporary restrictions on land use at certain disposal sites, and monitoring to ensure continuing adequacy of the engineered and natural barriers may be necessary. Institutional controls shall cease when there is no longer any need to restrict land use. Public health, safety, and full-cost analysis are all essential components of control criteria.

This rewording allowed consensus and satisfied many of the objections voiced relative to the words used in the proposed criteria. However, after extended discussion no consensus could be reached on the relative importance of cost factors in Criterion 4. All agreed that cost was an important factor, but no consensus could be reached on its significance. Some felt that, as was the case with safety, cost was a paramount consideration, while others felt that it was secondary in importance, that safety decisions

could not be based on cost considerations, and that costs should not be limited to economic considerations.

Other points which were discussed under Criterion 4 but on which no consensus was reached included the following:

1. It was thought that some criteria were extremely general and needed to be made more specific, whereas others were too specific and needed to be generalized.
2. Criteria should not require isolation and controls so stringent that the radiation levels that result from disposal are lower than those that would have occurred had the material been left in its natural state.
3. A "bottomline" acceptable risk must be specified before criteria are formulated.
4. All cost of control and disposal should be borne by those benefiting from the use of the technology producing the radioactive waste.

DISCUSSION OF CRITERION 5

Discussion of Criterion 5 centered around the need for it in general waste-disposal criteria. It was generally felt that the site-specific aspects of the criterion were incomplete and that they were more applicable to standards. Further, Criterion 5 as written provided no real guidance. Accordingly, the group recommended that the criterion be deleted or reworded to read as follows:

Locations for radioactive waste disposal should be chosen so as to minimize environmental and human health impacts and, wherever possible, to enhance isolation over time.

DISCUSSION OF CRITERION 6

Discussion of Criterion 6 led to the consensus that 6a was adequately covered by the rewritten Criterion 4 and should be deleted, and that the phrase "and other societal values" should be added after "public health protection."

Other points with regard to proposed Criterion 6 on which no clear consensus was reached included the following:

1. Retrievability of high-level waste seems incompatible with isolation and the minimization of institutional controls.
2. Criterion 6b should be broken up into two statements covering high-level and low-level wastes. To some, it seemed clear that it is often desirable to retrieve certain phosphate and uranium wastes which might have intrinsic value as a resource. On the other hand, others felt that high-level wastes, excluding spent fuel, had no apparent intrinsic value, and that the need for retrievability was based on some expectation of extracting transuranics or finding a future use for the material. The net benefits in this latter case may not justify designing for retrievability. It was also pointed out that, because of cost, it was probably impossible, short of extraterrestrial disposal, to prevent a determined future generation from getting to the waste.

3. Some said that in the initial 5- to 10-year period of the operation of a high-level waste depository, retrievability is necessary to confirm site suitability.
4. Cost-benefit analysis as a necessary element in any control criteria or deliberations on controls was discussed extensively.

The group had no problem with Criterion 6c as written in the EPA Background Report.

Some additional comments by individuals on the proposed criteria included the following:

1. An opportunity for involvement and comment on criteria (through workshops, for example) should be provided for state governments.
2. The problem of current wastes should be addressed as soon as feasible through the issuance of criteria and, ultimately, standards. However, the issue of criteria for and generation of future wastes needs to be held in abeyance pending the establishment of an adequate data base.
3. Since the "best possible" approach was being used in formulating the waste-disposal criteria under consideration, these criteria should be applicable to all waste--present and future.

WORKING GROUP III PRESENTATION COMMITTEE

<u>Name</u>	<u>Affiliation</u>
Stephanie J. Baker	Western Nuclear, Inc.
Tom English	California Institute of Technology/Jet Propulsion Laboratory
E. Lee Gronemyer	Washington State Health Division
William H. Harding	Drexel University
Judith Johnsrud	(with Environmental Coalition on Nuclear Power)
George W. Leddicotte	(with Florida Power & Light and a member of the Utility Waste Management Group)
Bob Mason	Gold Hill, Colorado
Philip L. Paull	Vermont Public Service Board
Tom Philbin	Ecological Analysts, Inc.
Roy G. Post	(with Univ. of Arizona Nuclear Engineering Dept.)
Roy Young	Colorado Recycling Cooperative Association

RESPONSES OF FORUM PARTICIPANTS TO SUMMARY
AND CONCLUSIONS OF WORKING GROUP III*

Second Plenary Session

CAROLYN LANDES: I wish Group III could have come up with a little more criteria to help me have some peace of mind about the current waste sitting around or shallowly buried and possibly leaking in the U.S. right now.

MIKE DOYLE: What this conference ultimately addresses is not radioactive waste disposal techniques, but [whether] we, as a society, will continue support of extremely high-technology, inherently dangerous, isolated energy production technologies. Instead, [we should] consider change in our lifestyle and ultimate values and begin support of permanent benevolent energy production.

STEPHANIE J. BAKER (Western Nuclear, Inc., Denver, Colorado): Regarding the term "consensus": The chairman of Group III insisted that only unanimity could be used to express "consensus"--I disagree; when only 2-3 individuals within a group dissent but the majority agrees, this should be so stated in the text of the proceedings. A minority opinion could also be included.

GEORGE W. LEDDICOTTE (Utility Waste Management Group): The responsibility of the EPA should be to establish an acceptable degree of risk to environment and public health associated with any activity judged necessary for the public welfare, in this instance the generation of power. In establishing the risks acceptable from radioactive wastes, the risks associated with producing electrical power by other means must also be considered. These risks should include such aspects as effects on public health, the national economy, depletion of natural resources useful for other purposes, etc.

We believe that nuclear power is a benefit to every individual in the U.S. It is now a necessary part of our national economy. Overall, nuclear energy, in both absolute and comparative terms, has already provided copious benefits in saving natural resources, preserving the environment, and in reducing health effects, thus saving lives.

However, the continuance of its beneficialities demands expeditious actions by the EPA and other regulatory agencies to provide satisfactory criteria and standards for waste management.

KATHRYN PARTRIDGE: Comments on the "irrationality" and "vested interests" of the anti-nuclear advocates have been made. Yes, I am irrational, if irrationality means sensitivity for others' welfare, concern for the future, and emotional insistence that we are dealing with living beings and not statistics.

Yes, I have a vested interest. I am 22 years old and hope to have children in the upcoming years. I do not wish these children to suffer the effects of radiation--leukemia, cancer, and heart disease. What technician or scientist has the right to dictate over the life and death of my child?

* Owing to failure of the tape recording system, only those comments submitted in written form are included here. However, this includes most of what was said.

COMMENT (name withheld): The use of the word "consensus" to mean 100 percent vote (not even one dissenter) made much discussion meaningless. The tactic overweights the feeling of the minority. As a result I think little was accomplished. I had the usual feeling of frustration at trying to design something by committee. We seem mostly to agree that it is indeed important to "get on with it." I don't think this is the way to do it.

BEVERLY HANNA THORPE (Ontario Ministry of the Environment): In establishing criteria for controls, it should be emphasized that there may be non-radiological components which pose health and environmental risks that must be contained. This is particularly important in such wastes as uranium mill tailings. Separate consideration of the radiological and non-radiological components, especially separation of jurisdictional control, should be avoided.

ALBERT BATES: Present shallow land-burial sites which contain long-lived or highly toxic radioactive wastes or which are now considered inadequate by any organization of government to actually contain the hazard should be considered, along with other forms of interim storage, as impermanent conditions. A timetable for transfer to permanent isolation should be developed and adhered to. This timetable should fall within a short term.

GARY BEACH (DEQ - Land Quality Division, Cheyenne, Wyoming): While establishing criteria, administrative capabilities as well as technological capabilities should be considered by EPA. This point is particularly important to extending the control criteria to encompass "mass waste," i.e., tailings, where institutional control shall be necessary for existing and produced wastes of the immediate future. State and local governments must be considered as institutions of control when relating to administrative capabilities.

FRANK ANDERS: What right does EPA have in pursuing controls of radioactive wastes--especially in light of the *CoPIRG vs. Train* Supreme Court decision?

DR. JAMES MARTIN (EPA): We have no doubt about our responsibility or authority to set environmental standards for radioactive wastes.

HENRY C. RAIBOURN: Should the nuclear industry involved be required to bear the total cost of disposal of all future waste in order to relieve the burden to the taxpayer and minimize the production of radioactive wastes?

STORM[so identified on card]: Battelle Northwest Laboratory Report BNWL 1900 was of the opinion that legal barriers in the form of treaties signed by the U.S. Government preclude [extraterrestrial, ice cap, or sea bed disposal of high-level waste].

C. B. PEARSON (Colorado Public Interest Research Group): All costs associated with the use or abuse of the various radioactive materials should be aboveboard and transmitted to the public. While the general public must eventually pay for all positive and negative aspects, these costs are not revealed to the public either through documentation of Federal tax money contribution to the nuclear industry and radioactive material research or through the standard utility bill. This should be done.

DR. CARL J. JOHNSON (Jefferson County Health Dept.): Because the EPA's proposed guidelines for exposure to plutonium and other transuranic elements (and their fission products) will relate to the control measures undertaken for radioactive waste, will the EPA have a hearing for those proposed guidelines?

MARTIN: These guidelines are in a formal process in EPA. A decision has not yet been made on whether to hold a hearing for the plutonium guidelines.

BOB MASON: General comment: Group III was able to achieve a significant and commendable dialogue within a remarkably short time. I believe that this demonstrates both the possibility and [the] desirability of extensive additional efforts on the part of the EPA to extend both the range and depth of these discussions. This extension must focus sharply on increased participation by the general public in face-to-face encounters with specialists representing industry, government, and a broad range of scientific and engineering disciplines. Only by this means, I believe, can irrational responses on all sides of this vital issue be replaced by reasoned, effective decision making.

STEPHEN K. BRESLAUER (NUS Corp., Rockville, Maryland): I am disturbed and disappointed in the attitude of many attendees that any individual who is not opposed to nuclear power or who does not espouse a radical position related to waste disposal is a tool of "industry" who is acting against the public interest. Professional and responsible environmentalists may in good conscience support nuclear energy and may even work for nuclear industries without compromising their integrity. Being "anti" is not necessarily "good." Being "pro" is not necessarily "bad." Individual issues should be dealt with constructively.

MIKE RAUDENBUSH: People in the industry are also citizens with a right to speak.

ROBERT W. POWITZ, Ph.D. (National Environmental Health Association): The concept of "multiple etiology" of health and environmental insults is widely recognized. Therefore, I recommend that any proposed criteria be reviewed and commented on by other branches of the EPA and other agencies such as: DOE, HEW etc. so as to assure consistency and compatibility with other regulations and agency missions.

I strongly recommend that any law specifying numerical criteria/standards promulgated by the EPA be so worded that adjustments due to emerging technology and new epidemiological findings can be made in either direction by consensus (or science court) rather than resubjecting the law to the entire legislative process. The error of the Occupational Health & Safety Act should not be repeated.

DAVID C. WILLIAMS (Americans for Rational Energy Alternatives, Albuquerque, New Mexico): The EPA is to be commended on trying to run the Forum fairly, but it should not make any pretense "The Public" was represented here. Most participants were either technically trained individuals strongly supporting nuclear energy or else individuals with a strong vested interest in opposing nuclear energy. Neither subgroup can be viewed as being at all typical of the general public.

DAVID LANDES: Concerning Criterion 5: I think it should read "Locations for radioactive waste disposal should be chosen for zero environmental and human health impacts and to enhance isolation over time."

BOB BOLAND (DOE, Las Vegas, Nevada): The difference between shallow land burial (confinement of waste) and the disposal (isolation) of high-level and TRU waste must be defined. Burial is confinement. Disposal is isolation, i.e. in a deep geological medium.

We have used "high level" and "low level" without definition. High-level waste is defined in 10 CFR Part 50 Append. F. This has some transuranics and all fission products. Low-level waste includes low concentrations of transuranics and all fission products--

and these are considered suitable for a shallow land burial type waste management operation.

DR. TOM ENGLISH (Jet Propulsion Laboratory, Pasadena, California) [comment on agenda Issue 6]: "Is best available technology necessarily acceptable?" Are bedded salt, sea-bed, transmutation, and space disposal considered "available technologies" for high-level waste disposal? Are there any available technologies for high-level waste disposal? Furthermore, does the United States even have a spent-fuel policy which allows electric utilities to transfer spent fuel to the government for ultimate disposal?

MARTIN: Before we adjourn I'd like to thank each of you for attending this Forum and giving your time and effort on our behalf. I'd also like to compliment you on the hard work you did and the commitment to stick to the job, which at times went well into the night. You have made sure that EPA has its work cut out in order to finalize the criteria. I'd also like to compliment the EPA staff for their contributions, and to extend gratitude to Al Hazle of Colorado and Hall Bohlinger of Louisiana for pitching in on short notice to moderate working sessions for us. Finally, I'd like to thank our contractor, Ecological Analysts, Inc., for running a smooth meeting so the rest of us could devote our efforts to the work of the Forum. Thank you for coming.

PREPARED STATEMENTS FROM THE PUBLIC

STATEMENT OF AMERICANS FOR RATIONAL ENERGY ALTERNATIVES, INC.
(PREPARED BY DAVID C. WILLIAMS, PH.D.*)

BIOGRAPHICAL NOTE

Dr. David C. Williams received a bachelor's degree in chemistry from Harvard University in 1957 and a Ph.D. in nuclear chemistry from the Massachusetts Institute of Technology in 1962. He was a postdoctoral fellow specializing in nuclear research from 1962 to 1966, first at Princeton University and then at Los Alamos Scientific Laboratory. From 1966 to the present, he has been a member of the technical staff at Sandia Laboratories, Albuquerque, N.M. Major work areas have included safety analysis on radioisotope powered generators intended for space use, vulnerability studies on reentry vehicles, and LMFBR safety research. He has also performed evaluations of the hazard potentials of nuclear wastes for Americans for Rational Energy Alternatives (AREA), a New Mexico citizens' group concerned with energy and environmental problems.

INTRODUCTORY

The following comments on the Background Report and the proposed Environmental Protection Criteria for Radioactive Waste are divided into two parts. The first part includes commentary on the report in general, while the second is restricted to comments specific to the proposed criteria. The Background Report is understood to reflect the factual and philosophic basis that underlies the proposed criteria, and we likewise believe that the comments offered with respect to it are necessary to fully appreciate the basis of our suggestions with respect to the criteria. Hence, it is our strong hope that the Environmental Protection Agency will carefully consider all parts of our commentary.

I. COMMENTS ON THE BACKGROUND REPORT

General

The discussion of the risks associated with very long-lived wastes is unnecessarily vague and nonquantitative. Partly for this reason, and partly because of the repeated allusions to the longest-lived isotopes and to very long time periods (e.g., pp. 1, 9, 10, 16, 17, 18, 19, 20, 21, etc., etc., etc.), the report appears to give excessive emphasis to the small fraction of the total radiological hazard that actually is longer-lived than a few hundred years. Nowhere in the report is it pointed out that the longest-lived materials are produced in correspondingly smaller amounts, in terms of radiological hazard measures. More quantitative discussions of some aspects of this point are given later.

Page 1, Paragraph 2. The assertion is made that "It is generally conceded that risk estimates for many of the long-lived radionuclides would depend on numerous imprecise variables which would be little more than speculation after certain time periods." It is then concluded there could result "intense controversy over any calculations" underlying any criteria or standards, etc. At best such statements would be true only of the exact values of the numerical risk estimates. Such estimates are not necessary for environmental protection criteria or standards, however; it suffices only to convincingly

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demonstrate that the risk is less than some upper limit value which is itself acceptably small. Strong arguments can be advanced (e.g., Cohen 1977) for believing that this is indeed the case; in fact, we are not aware of any quantitative arguments to the contrary that cannot be readily refuted.

Page 9, First Paragraph. The statement "Long-lived wastes are especially significant ..." is subject to the general comment made at the beginning of this review. Implications of these materials' long lifetimes is considerably mitigated by their relatively low total hazard potential, at least insofar as ingestion is concerned. For transuranics (TRU), inhalation hazard potential per gram is much greater than the ingestion hazard potential per gram. Thus, the "special significance" does not seem warranted unless exposure paths involving dispersal as a respirable aerosol are likely. A careful evaluation of these clearly would be appropriate.

Page 10, Second Paragraph. The statements concerning I-129 and C-14 seem unnecessarily alarmist unaccompanied as they are by any qualifying remarks concerning the amount assumed to be released or resulting radiation exposures. I-129, for example, will probably not be "volatile" in any form chosen for long-term disposal, and in any case, it is produced in such small amounts that it is difficult to see how significant exposures could occur except locally.* The statement that C-14 "if released to the biosphere, would represent exposure of the entire world's population" is true only in the sense that "a single breath exhaled by a single human being pollutes the entire atmosphere" represents a true statement. Either C-14 release must be enormously large or the dose will be meaninglessly small. Unfortunately, the average reader will have little appreciation of this fact.

Page 14, Paragraph 2. Here and elsewhere (e.g., page 30), reference is made to the linear dose-response hypothesis (for estimating health effects due to low radiation exposures) as if this hypothesis were among the most well-established of natural laws. Actually, as the EPA is surely aware, this assumption is highly controversial. It is our understanding that linear dose-response is considered fairly respectable for estimating effects due to alpha radiation and other high-LET† radiation, but that it almost certainly seriously overestimates the risks due to low levels of beta and gamma radiation. Concerning the latter, Report #43 of the National Council on Radiation Protection and Measurements holds that risk estimates based on linear dose-response "cannot be expected to provide realistic estimates of the actual risks from low-level, low-LET† radiations, and have such a high probability of overestimating the actual risks as to be of only marginal value, if any, for purposes of realistic risk-benefit evaluation." (NCRP 1975; emphasis original.)

*At current world-wide production rates, if all I-129 were disposed of by simply dumping it in the ocean, over 1,000,000 years would be required to reach a few tenths of one per cent of the most conservative of the maximum permissible concentrations that have been established for I-129 in drinking water. Even allowing for the biological activity of iodine, it seems most difficult to construct an environmentalist doomsday scenario based upon this nuclide.

†LET $\equiv$ linear energy transfer. Alpha radiation is high-LET, beta and gamma (e.g., fission products) are low-LET.

In view of the very controversial nature of the linear dose-response assumption, we find it both surprising and disturbing that the EPA Background Report simply asserts it as law without debate, comment, or even a reference to the technical literature on the subject.

Page 15, First Paragraph. We believe nothing useful is accomplished by distinguishing between existing wastes and wastes to be produced in the future. We cannot imagine why the amount of time, effort, resources, etc., that is justified in being spent in order to mitigate a specific health effect, for example, should have any explicit dependence upon whether the waste responsible for that effect was produced before or after some particular date. The argument that existing waste has no benefit associated with it seems specious: there obviously was a benefit associated with it at the time it was produced, and the fact that the association of this benefit with the waste is no longer immediate or directly observable is hardly a reason for treating the waste differently from that to be generated by similar activity in the future. By the time that future waste is ready for disposal, the benefit associated with its production will be "past" also.

As a matter of fact, many human activities (mining, automobiles, etc.) can be interpreted as generating adverse environmental impacts (e.g., land spoilage and water pollution from mining, automobile exhaust gases, etc.) which have no use. For obvious reasons, these purely adverse impacts are regarded as being part of the price paid for the benefits. We see no rational reason for treating nuclear waste in a very different manner, i.e., artificially divorcing it from the benefits of the activity producing it and then announcing that it will be subject to uniquely severe restrictions on the grounds that its risk now has no "benefit" associated with it.

Page 15, Paragraph 2. We are disturbed to see the credence EPA seems to be giving to the notion that the benefits of activities producing radioactive wastes might not justify the risks associated with the wastes. All evidence available to us indicates these risks can be kept very small. In contrast, the activities producing such wastes are vital to our nation's defense and probably equally vital to our national energy programs: two of the most urgent and potentially dangerous problems confronting our nation today. Risks to our national and even personal survival would be incalculable if all nuclear activities were abandoned. Nowhere does the Background Report seriously acknowledge these risks. Yet the report seems to be giving credence to the notion these risks might have to be accepted because of the alleged "menace" posed by radioactive wastes; worse, it seems willing to allow this notion to affect the formulation of policy in disposing of radioactive wastes.

Furthermore this question clearly transcends the jurisdiction of the EPA; society as a whole must make the ultimate risk-benefit decision. The EPA should limit itself to establishing reasonably conservative (but not excessively conservative) criteria in accordance with society's (admittedly vague) standards for making risk/benefit decisions in general. Here the "benefit" is not the benefit of the waste-producing activity: it is only the benefit of saving the additional costs associated with further reduction of risks. Once this approximated break-even point is (roughly) determined, it is up to a broader segment of society to decide whether the residual risk is indeed worth the benefit of the waste-producing activity.

Page 16, Top of Page. We do not see how serious attention can be given to the notion that risks to future generations must be zero, since it would be totally impossible to apply such a notion on a society-wide basis: almost any human activity involves some degree of risk. The most that could be rationally argued is that future generations, being uninvolved, should be subject to no more risk than we consider acceptable for

other "third party risks," i.e., risks to people who are not involved in the activity, receive no direct benefit from it, and have no choice in being subjected to it (the risk to people on the ground from falling aircraft is a commonly cited example).

We ourselves strongly endorse the belief that future generations are indeed beneficiaries of properly designed technological activities. Indeed, all societal decisions, positive and negative, affect the future in some degree and therefore leave "legacies" of some kind. For example, we can think of few "legacies" for future generations more "immoral" than a planet stripped of easily exploited fossil energy reserves combined with a society devoid of the technologies needed to exploit advanced energy sources. Nonetheless, we believe the "third-party risk" viewpoint is one that can at least be reasonably admitted to discussion; indeed we believe risks probably can be kept within the limits such a viewpoint would suggest.

Pages 17 - 21. Here and elsewhere the discussion appears to give excessive emphasis to extremely long time periods, "legacies," and uncertainties involving the distant future --at least, insofar as the man-made radionuclides are concerned. We believe actual risks to future generations will be very small and the excessive emphasis on legacies, etc., is unjustified. We will illustrate our point with the hazard posed by wastes from light-water reactors (LWR's) since these are currently the largest single source of man-made waste generation. We assume wastes will be buried in deep-lying, stable geological formations and analyze the problem in terms of the ingestion hazard potential, since ingestion following migration in ground water is generally believed to be the most likely pathway for human exposure, as is implied in the Background Report, page 28 and elsewhere. We would note the following main points (additional details on some of these points are given in Appendix A):

1. Hazard potential of LWR wastes initially declines rapidly during the first few years following removal from the reactor. During the period of a few years to a few centuries, the ingestion hazard potential is dominated by Sr-90 and, to a lesser extent, Cs-137, both of which decay with half-lives of slightly under 30 years. At 300 years, the total residual hazard potential is about 1,000 times less than its value at 10 years; at 1,000 years it is over 10,000 times smaller than the 10-year value (Cohen 1977). Only a portion of even this very small remainder lasts for the very long times (hundreds of thousands or even millions of years) commonly cited in popular literature, including the Background Report.
2. Because of the relatively rapid decay of the wastes, if future generations produce waste at the same or greater rates as "we" produce it, most of the total hazard potential present at that time will be "theirs," not "ours." In this case, the much-discussed question of "legacy" scarcely arises. Only if waste-producing activities decline at rates greater than the decay rate of the wastes might future generations find themselves with a hazard potential "bequeathed" from past generations greater than what they themselves were producing. Though not impossible, we consider this unlikely; see Appendix A [of this statement].
3. Actual risk at any future time is roughly proportional to the hazard potential at that time multiplied by the probability of being exposed to the waste (or any given fraction of it) at that time, other things being equal. Emplacement of the waste in a permanent repository should represent a large reduction in the exposure probability compared with the exposure probability associated with management in temporary facilities at the terrestrial surface (tanks, cooling pools, etc.). Probability of exposure at any given time should remain small in the distant future and may even continue to decline (Appendix A). We know of no mechanism permitting

exposure probability to increase with time sufficiently to compensate for the very large reduction in hazard potential. Hence, risks, in the distant future should be very small compared with present risks, even though all technical estimates show the latter are themselves very small by normal societal standards.

4. In the Background Report and in much popular discussion of the issue, there seems to be a tendency to confuse two quite different concepts: the probability of exposure to the wastes at some specified time in the distant future (directly related to the risk experienced by the generations living at that time), and the total probability that release might occur sometime in the future. The latter probability obviously does increase as "the future" is indefinitely extended.
5. It might be argued that the goal should be limiting the total future expectation of harm, i.e., the risk integrated (summed) over all time, to being less than the expectation of harm we are willing to accept for just the present generation. Though we believe this more stringent goal may indeed be achievable, we do not believe it can rationally be required as a necessary condition for reasons which include the following:
 - a. In addition to producing radioactive materials, nuclear reactors destroy uranium isotopes, and, hence, reduce future environmental exposures due to uranium + daughters (Ra-226, Rn-222, etc.).
 - b. If integrated indefinitely over geologic time, the hazard potential of the radionuclides eliminated from the environment greatly exceeds the time integrated hazard potential of radionuclides added to the environment [the difference is two to three orders of magnitude at least (Cohen 1977, Williams 1977)].
 - c. By careful selection of the burial site, it should prove possible to keep the probability of exposure to the wastes small compared with the probability of exposure to the natural uranium + daughters, which are disturbed more or less at random. Hence, the time-integrated expectation of harm due to the uranium + daughters destroyed by the reactor should exceed that of the wastes produced by factors even larger than those applicable to the hazard potentials.
 - d. Current NRC regulations for LWR's require radiation reduction to levels as low as practicable at costs of up to \$1,000 per man-rem reduction of dose-commitment. Rough calculations (Williams 1977) show that the reduction of ultimate dose-commitment by destroying uranium in reactors is likely to be approximately an order of magnitude more cost-effective, and thus mandatory if one combines current standards of acceptable radiological risk with the time-integrated expectation of harm concept.

We believe it is very questionable to place mandatory limits on the expectation of harm due to an activity while ignoring a benefit resulting from the activity that is the same in kind and much larger in magnitude. It likewise makes no sense to require a given level of expenditure to reduce a man-made hazard when the same level of expenditure would result in a reduction of a natural hazard that is similar in kind and greater in magnitude. We conclude, therefore, that this condition (assuring the time-integrated expectation harm to be less than that which the generation producing wastes will accept for itself) cannot rationally be made a necessary condition.

6. Additional assurance that future risks can be kept very small may be gained from the following perspectives:

- a. If wastes are to be deeply buried, it is reasonable to compare their hazard potential with that of the natural radioactivity, especially Ra-226, already present in the ground down to comparable depths (2,000 feet, say). Even if all U.S. electric power generation were nuclear, the hazard potential of one year's wastes at the time of disposal would be less than 0.1 percent of that of the Ra-226 in the U.S.; after 1,000 years, it would be less than 0.00001 percent of that of the radium (less, in fact, than that of the radium underlying just one square kilometer and within 2,000 feet of the surface).
- b. After only 250 years, the wastes' hazard potential is less than that of the uranium ore from which the wastes were ultimately derived; leaving this ore in the ground would not be generally considered unacceptably hazardous even though the ore is much less carefully buried than the wastes can be and has an effective half life of 4.5 billion years (that of U-238).
- c. The fact that the wastes are more concentrated than the natural radioactivity does not invalidate comparisons such as these (see Appendix A).
- d. From these facts, it is readily shown that future risks will be extremely small provided the wastes are managed so as to be no more accessible, on the average, to the biosphere than is the natural radioactivity within the top few thousand feet of the ground. We consider it less than credible that modern technology cannot achieve this goal, at least to the extent that the full burden of proof must rest with the contrary view.

To Sum Up: We believe there are very strong reasons for expecting that risks to future generations from man-made radioactive wastes can be kept minute indeed, and the vague and ominous tone of many of the discussions in the Background Report seems quite unwarranted. We also recommend that the EPA consider the following two guidelines in setting environmental protection criteria for radioactive wastes:

1. A necessary criterion is that risks to no future generation exceed risks we the producers of the wastes are willing to accept ourselves.
2. A sufficient criterion shall be that the time-integrated expectation of harm be no greater than what the waste producers will accept for themselves. This criterion is clearly not necessary since its consistent application would require that we spend enormous sums of a fission reactor program for the sole purpose of eliminating uranium from the environment, and we judge it very improbable that such a program implemented for this purpose only could win public acceptance.

Page 22, Paragraph 1; Page 29, Paragraph 1. Here and elsewhere, reference to "total isolation" over the "hazardous lifetimes" seems to imply an absolutist, either-or, on-off approach to radioactive wastes that we feel is very inappropriate, since (a) EPA makes risk assessments on the basis of the linear dose-response hypothesis, and (b) the "hazardous lifetime" is very ill-defined, the wastes' hazards varying continuously with time as they do. Evaluation of acceptability must likewise be in graded terms, e.g., times, probabilities and amounts of possible release, and amount of hazard potential at the time of release.

Pages 24 - 27. We find the discussion of uncertainties here to be of questionable utility, partly for reasons already noted previously. The use of Rochlin's "three time periods" seems especially dubious for the current problem. We would, of course, agree that safeguarding some wastes should not be relegated indefinitely to human institutions, but not because the latter show a rapid increase in "breakdown probability" after 100 years. We know of no reason to believe this probability should increase rapidly after the next 100 years. Indeed, it could be rationally argued that there are a number of crises

confronting mankind (population, economics, energy, resources, environment, etc.) all capable of causing social breakdown in less than 100 years if not properly addressed, while breakdown would then be less probable after this period if these problems are met. Once again, there seems to be confusion between the probability of an event occurring per unit time versus the integrated probability that it will occur at some time in the future.

The reason that engineered/environmental barriers are to be preferred is that, if properly chosen, they should prove far more reliable than institutional safeguards--today, tomorrow, and forever, unless drastic improvements in the reliability of human institutions occurs.

Page 30, Paragraph 2. All societies, not just those dependent upon high technology, involve nonzero risks; indeed, risks are typically much greater in nontechnological societies.

Page 30, Paragraph 3. See comments concerning Page 14, Paragraph 2 with respect to application of the linear dose-response hypothesis.

Page 31, Bottom--Page 32 Top. The proposal offered by Starr for risk acceptance seems to have been dealt with unnecessarily negatively in view of the fact that the objections raised to it can be at least partially answered:

1. Though the risk-benefit relations would indeed be difficult to assess at all accurately, it often would be possible to demonstrate that a given risk is very small compared with other accepted risks of comparable benefit. In this case, a precise relationship would not be necessary.
2. Though the results would describe "circumstantial" rather than "optimal" risk-benefit relations, certain influences do exist to force some rough approximation to whatever society considers "optimal," perhaps more so than could be done by arbitrary regulatory decree.
3. The problem of changing perspectives applies to all present-day decisions insofar as they affect the future.

Page 32, Second Paragraph. Though exposure to the risk of natural background radiation is involuntary, exposure to variations in this background is not involuntary. Considerable variation in background exposure is associated with one's choice of geographical location, construction materials for dwelling, etc. Generally speaking, these variations are universally ignored by the public. Few if any are those who choose their place and type of residence with minimization of background radiation as an important factor. Perhaps the most eloquent testimony to the lack of importance generally ascribed to these variations is that they are rarely if ever used even in ulterior promotional appeals. That is, appeals based on reduced background radiation are not used to promote wooden home construction; real estate developers in low-radiation regions make no appeal to this fact nor do they try to scare people into leaving high-background regions such as Albuquerque, New Mexico and Denver, Colorado. For that matter, we are not aware of antidevelopmental groups in the latter areas using the high background radiation levels in their attempts to get people to stay away.

Variations in background are, then (a) generally ignored as trivial, and (b) associated with risks of the same kind as those associated with radioactive wastes. Hence we

recommend these variations as a potentially very useful yardstick for measuring the acceptability of the latter risks.

Pages 33-36. Several good points are made in the discussion of assessing attitudes and opinions of the public toward risk. However, the most important reason of all for not basing policy solely on "acceptability" in the public opinion sense is omitted: the public itself may have a grossly distorted impression of the hazard, greatly exaggerating it (or underestimating it, for that matter). We believe that this is unquestionably the case for radioactive wastes. There are many reasons for this exaggerated perception of the risks; one is the treatment of the subject by certain elements in the news media.

Under our system of government, a great many decisions must be made by duly authorized agencies, not the general public, especially when complex technical issues are involved. At the Albuquerque Workshop, pollster B.W. Roper pointed out that a large majority (64 to 24 percent) of the public itself believes that the proper disposal of nuclear wastes is a question that should be resolved by expert groups, not the public (EPA 1977). In passing, we note that opinion gathering in public forums and the like (Background Report, p. 33) would be extremely misleading: inevitably, the majority who believe the question should be left to experts are unlikely to participate in such forums, and the "sampling" will be drawn very largely from the minority.

We are not, of course asserting that the basic value judgments which ultimately underlie any risk/benefit decision should be "left to the experts." This judgment is to be made by society as a whole, in some sense. However, evaluation of what the risks are, and thus determination of whether society's criteria for the risks being worth the benefit have been met, is something that must be left to the experts. Opinion polling, to be very useful, would have to separate the public's attitude toward what constitutes an acceptable risk from public belief as to how large a particular risk is, since the latter may well be factually in error.

Page 37, Main Paragraph (end). Whenever referring to prevention of exposures "in excess of background levels," one should include a qualifying word such as "significantly," e.g. "significantly in excess of... ." It is often impossible to avoid some increase, though the increase may not be directly measurable. Here "significant" might be defined to mean equaling or exceeding the routinely ignored variations in background levels noted earlier.

Similar qualifications should be added elsewhere, e.g., page 41, second paragraph, etc.

Page 39, Top Half. Considering that they are advanced as "necessary conditions to be satisfied . . ." (emphasis supplied), some very questionable statements are asserted here with essentially no admission that opposing views might exist. An example would include the assertion that chronic exposures to any organ (emphasis supplied) must be small compared with the natural background. The "necessity" for this restriction is far from established and in any case is more likely to be plausible for some organs (gonads, whole body) than for others (thyroid, lymph nodes).

Page 40, First Full Paragraph. As noted earlier (comments on Page 15) we do not consider it valid to separate the "useless" waste from the beneficial activity producing it and then subject waste management to especially severe restrictions on the grounds the waste has no "benefit" associated with it.

Page 40, Bottom. We agree that it is not useful to be greatly concerned about designing against events which would independently have consequences much more severe than

the effects of the wastes. With some qualifications, we would include the notion that future generations might forget about or lose track of the wastes as being such an event. The qualifications are that we assume major repositories will not be unlimited in number and might be supplied with some kind of passive advisory marker. Major repositories will then be very substantial installations, and loss of all records as to their purpose plus loss of ability to interpret the marker implies a truly catastrophic collapse of our civilization such as might result from nuclear war, social chaos due to an extreme energy famine, etc. Thus, this problem appears to fall in the category of "events independently having much greater consequences."

Page 41, First Full Paragraph. We agree that risks should be "equitably distributed," provided that it is clearly understood that "equitably" does not necessarily mean "equally." Risks are almost invariably unevenly distributed; for example, the risk to people on the ground from falling aircraft is obviously much greater for people living near airports than for people far from airports. "Equitable" should be defined to mean that no one individual or group of individuals be subjected to excessive risk; that is, the risk must be kept reasonably small even for those whom the risk is largest.

II. COMMENTS ON THE PROPOSED CRITERIA

The following comments are keyed to the numbering system used in the Background Report, pages 50-53.

Item 1. We are not certain that it serves any useful purpose to have the origin of radioactive materials (e.g., fission reactors) included in the definition of radioactive waste. The ultimate goal of environmental protection criteria is to control public radiation exposure in both the present and the future; the origin of the radionuclides involved is at most of secondary concern. Singling out specific sources seems to invite applying disproportionate attention to some sources while other sources of comparable significance may be neglected. We would suggest that radioactive waste be defined as material that:

- (a) has no likely resource or product value; and
- (b) could result in a significant increase over natural background exposure to human beings, either in the present or in the future, if discharged into the environment in an uncontrolled manner.

Here as elsewhere in our discussion we would define "significant increases" such that increases in exposure small compared with the routinely ignored variations in background radiation would not be considered significant. In applying this criterion, we believe that it might be reasonable to exclude certain highly anomalous extremes in the natural background (e.g., monazite sand regions) that affect relatively few people. We would also agree that it might be reasonable to control smaller radiation doses provided the cost is not excessive as judged by some realistic cost-benefit criterion (see below).

Item 2. We endorse the concept that environmental protection determinations should be based "primarily on an assessment of risk to individuals and populations." We believe, however, that here and elsewhere it will be necessary to judge risk reductions according to some cost-benefit criterion. Implicitly, some such criterion will always be involved, since at least some further reduction of risk can always be achieved if cost is truly no object at all. So long as such criteria are left implicit, there may be some danger that efforts not be allocated as effectively as possible (an example would be the disproportionately small amount of effort devoted to minimizing unnecessary medical radiation exposure in comparison with the standards of the nuclear industry). For this reason and others, we believe the EPA might consider using explicit cost-benefit criteria, at least

in an advisory role or perhaps in conjunction with other factors, in determining at what point further precautions would no longer be justified.

As an example of the type of criterion that might be used, we note the NRC requirement of expending up to \$1,000 per man-rem reduction in dose commitment (we are only illustrating the concept, not endorsing the numerical value). This approach could be refined; for example, the formula could take into account whether the whole body or just one or some specific organ(s) would be exposed; available information on the radiosensitivity of the exposed organ (e.g., BEIR 1972) could be factored into the criterion. It would also be necessary to distinguish population exposures that would be accumulated over time periods of the order of a human lifetime or less from those that would be accumulated over much longer time periods. A probabilistic approach might be applied to exposures that would occur only in the event of mishaps.

We realize any such guidelines could only be imprecise at best and would be attacked as "putting a price on human life," etc. However, some such decision on cost-benefit will always be implicit in any regulatory decision as to what should or should not be required, and the charge of "putting a price on human life" will always be leveled by those who find their interests to be advanced by making such charges. We believe the net effect will be beneficial if we make our implicit cost-benefit criteria more explicit and more nearly objective, provided always that it is set at a reasonable level as judged by society's willingness in general to increase economic costs in order to reduce risks.

Item 3. The notion that any risk is somehow unjustified is totally discordant with society's attitude toward all other risks (below certain ill-defined levels, they are simply ignored). The qualification starting with "unless..." is too vague to be very useful; taken literally, it is universally applicable and thus applies to the risks just noted that society accepts because further risk reduction would be "unreasonable in view of technical, economic, and social considerations." We believe it would be more helpful to use language such as the following: "The acceptability of risks due to radioactive waste must ultimately be judged in terms of:

- a. risk-benefit criteria applied to the activity producing the waste; and
- b. cost-benefit criteria as applied to the social and economic cost of imposing additional restrictions to achieve further risk reduction.

The second criterion is the one of primary concern to the EPA; a much broader segment of society must be involved in the first judgment.

Item 3, Second Sentence. We would suggest simply saying "risk" here, not "potential risk." "Risk" associated with an unplanned or accidental event may be defined as being equal to the probability of the event's occurring multiplied by the consequences resulting if it does occur. In loose discussion, "potential risk" is sometimes used to mean consequences only, not allowing for the probability of the event; no end of confusion often results in such discussions of "risk."

Item 3a. The wording here is confusing. Is it intended to say that disposal methods will be unacceptable if they result in a high probability of there being radiation exposures producing acute effects, and further application of reasonable controls could not reduce the magnitude or the probability of such exposures? Or is something else intended? In any case, we found the meaning obscure.

Items 3b and 3c. These reiterate the notion that to be acceptable, risks associated with radioactive wastes must be less than other acceptable risks. The only justification offered was the very artificial separation of the wastes from the beneficial activities

producing them and subsequent characterization of the wastes as being "without benefit." As noted in our Comment with respect to Page 15, we believe this unique approach to radioactive wastes is totally unjustified. Hence, we cannot accept the notion that risks associated with radioactive wastes must in principle be kept less than other acceptable risks. In practice, we believe application of reasonable cost-benefit criteria to risk reduction will result in levels that are low compared with many risks. What we do not accept is the notion that comparisons with other accepted risks may not be "good enough"; that radiation risks are somehow special and must meet criteria not generally imposed in other areas.

Item 4. We would question the wisdom of issuing specific, definite restrictions on policy which are intended to be universally applicable, as was done here in prohibiting restrictions on "customary uses" of land areas and surface and ground water lasting longer than 100 years. Natural characteristics (mineral content, presence or absence of water, etc.) of many parts of the terrestrial surface and subsurface often impose restrictions on usage which last indefinitely. It may be unreasonable or impractical to require that human activity involve no such restriction. This is especially true when the human activity only involves relocation of natural radioactive materials. Probably aquifers penetrating natural uranium ore bodies would be at least locally unfit for human consumption, and we are not certain that it will be practicable or reasonable to require the tailings resulting from mining such ore to be disposed of in such a way that no future restrictions are needed. For example, the nature of the tailings piles is such that, were it not for their radioactivity, a "customary use" might be construction materials. Activities involving removal of any covering applied to the tailings might have to be restricted, water in and below the tailings may be nonpotable, etc. Note that similar restrictions, especially for water usage, may result from other landfill operations, e.g., disposal of fly ash and sulfate sludge from coal-fired plants. Even a deeply buried waste repository could be interpreted as imposing restrictions on subsurface land and water use.

We believe a better approach might be to formulate guidelines such that the total land area dedicated to waste disposal in any way would be acceptably small even if it were assumed disposal activities continued for a very long time in the future. This should not present any great difficulty. Mill tailings will never occupy more than a modest amount of land because of the limited amount of uranium ore in existence. Disposal requirements for high-level wastes should also be small, with about 150 square miles reportedly being adequate for the order of 1,000 years' U.S. waste production even assuming major usage of nuclear energy throughout the period (Cohen 1977), and long-term restrictions would only be required for the deep strata actually used for disposal.

The requirement that "as many physical and natural barriers as is practicable" be used for long-lived wastes should, of course, be subject to cost-benefit analysis.

Item 5. We are not certain as to what is meant by choosing locations such that "natural forces...improve...isolation"; this concept was not discussed in any detail in the text. Is the idea to prefer regions where net deposition currently exceeds net erosion? If so, we have misgivings; areas of net deposition may be regions of high geological activity, high permeability to ground water, etc., that would be less suitable than highly stable geological formations that are currently undergoing net erosional effects but at a low and relatively predictable rate. The key point is the importance of future predictability. In any case, the idea advanced here needs much more explanation and analysis before accepting it as a general criterion for waste disposal.

Concerning the last sentence of Item 5, this should specify moving or circulating water. Stagnant water (e.g., the aqueous inclusions found in rock salt) may be much less important if it can be demonstrated that subsequent migration is improbable even if the wastes do interact with such water.

Item 6. Any "additional procedures and techniques" introduced should be judged by some reasonable cost-benefit criterion.

General. We believe there is a need for a much greater emphasis on cost-benefit criteria than is found in the detailed wording of the environmental protection criteria. Other things being equal, it will obviously be desirable to meet the various criteria offered in the Background Report, but some of them should be offered as optional guidelines or rules of thumb helpful in forming judgments, not rigid dictates to be obeyed slavishly without regard for whether the cost required to do so in specific instances is in any way justified by the benefit obtained. In estimating "cost" of additional control measures, all costs (indirect impact on other activities, costs of delay, etc.) should be included, not just the direct financial outlays required. Indeed, cost estimation should be about as conservative as risk estimation.

As we noted earlier, when time periods long compared with human lifetimes are involved, it is necessary to distinguish between the risks to any one generation and the total, time-integrated expectation of harm. A similar distinction is required when discussing population exposures over very long time periods. If the ultimate time-integrated values of these quantities are ascribed any significance at all, the ultimate radiological benefit resulting from activities that eliminate uranium from the environment cannot be neglected.

Finally, our greatest concern has to do with the possibility that the EPA may be setting the stage for a degree of restrictiveness that cannot be justified on any technical or objective grounds. We find especially disturbing the repeated denigration of quantitative risk estimates that appears in the Background Report from Page 1 to the final summary, e.g., the assertion on Page 48 that, for long time periods (over 1,000 years), risk predictions "for practical purposes...would not generally be dependable, informative, and therefore not very useful..." Though the relative uncertainty in the risk may indeed be large, such predictions would still be fully useful if the absolute uncertainty is small, i.e., if they can show the risk to be less than some upper limit which is itself very small. We believe detailed risk evaluation studies now in progress will prove this to be the case; at the very least, the EPA should acknowledge the possibility.

Unfortunately, the EPA gives the impression--perhaps unintentionally--of laying the groundwork for discounting the results of the best technical estimates of risks and permitting regulation, instead, to at least partially reflect the widespread fears that radioactive wastes represent some unprecedented threat to the environment requiring uniquely different standards of control.

We are all too aware that such fears are indeed widespread today and that they have built up a potent sociopolitical momentum. Powerful individuals and groups have committed themselves to the idea that the radioactive waste problem exceeds human capabilities to find solutions; these interests would find it difficult or impossible to admit error on the question without losing much of their prestige, political influence, and sense of personal importance and worth. The EPA must, however, stand firm against pressures from all such vested interests and base policies solely on the best technical analyses available. To do otherwise would violate the trust bestowed upon the EPA by

the law of the land--a trust to protect the environment without unnecessary interference in the activities essential to the very survival of our civilization.

APPENDIX A

RISKS IN THE DISTANT FUTURE: THE QUESTION OF "LEGACY"

In this Appendix, we elaborate on certain aspects of the comments offered with respect to the Background Report, Pages 17-21, concerning the longevity of radioactive wastes and the so-called "legacy" they constitute for future generations.

As noted in the main text of our comments, over 99.9 percent of the initial ingestion hazard potential of the wastes decays with an effective half-life of 30 years or less. This means that most of the hazard potential of wastes on hand in the future will have been produced by the generations living then, not past generations, if waste production continues at current rates or increases. In this case, it is not very meaningful to speak of the "legacy" of the present generation's wastes.

Only if future waste-producing activities decline at a rate greater than the decay rate of the wastes might future generations find themselves with a hazard potential "bequeathed" from past generations greater than what they themselves were producing. Whether this is credible is difficult to say. Given the abrupt onset on universal brotherhood and good will, production of defense wastes could terminate almost overnight; unfortunately, there is little in human history or current events that suggests this is about to occur. In any case, wastes from civilian energy generation now dominate the total hazard potential of all wastes currently being produced, and this trend is expected to continue in the foreseeable future. Historically, about sixty years has been required to engineer major changes in energy use patterns (ERDA 1974). Thus, it seems likely that the use of nuclear energy for civilian purposes will not decline more rapidly than the decay rate of the wastes themselves, even assuming better energy sources are developed.

Future Exposure Probabilities

Roughly speaking, actual risk at any given future time, other things being equal, is proportional to the product of the hazard potential of the waste at that time multiplied by the probability of exposure to the waste (or any given fraction of it) at that time. If the probability of exposure per unit time increases more rapidly than the hazard potential decays, then the actual risks can increase with time. Thus, for current LWR wastes, if the probability of ingesting them in the year 3000 A.D. will be 100,000 times greater than the probability of ingesting them in the year 2000 A.D., the risks in the former year will be greater even though the hazard potential will have declined by a factor of 10,000 or so.

Actually, we believe the likelihood of exposure at any given time in the future should be less than the likelihood of exposure of the present generation. Radioactive materials are presently produced, used, and stored in a variety of activities at the terrestrial surface where they would be more or less accessible to the biosphere if released. Whatever final disposal technique is selected, there is general agreement that it should be an improvement over surface storage in tanks, fuel pools, and the like. Hence, a sharp reduction in exposure probability should accompany final disposition.

Behavior of the exposure probability per unit time in the distant future is more difficult to predict and, in any case, depends upon the disposal method. For some exotic disposal

methods that have been proposed (deep space disposal, nuclear transmutation) this release probability is obviously zero for the distant future. Even for the more likely method of burial in deep, stable geological formations this release probability may well decline with time. To see this, we note that the intent of any such repository would presumably be to isolate the wastes until essentially harmless if the repository functions as designed; the risk is therefore that associated with unpredicated breaching of the repository. Events potentially capable of causing such breaching can be divided into various categories:

1. Natural events unrelated to the fact that waste burial has taken place.
2. Events involving a combination of natural events plus effects due to waste burial (e.g., improperly sealed mine shafts).
3. Inadvertent future human penetration.
4. Deliberate future human penetration.

The first probability will not vary strongly as a function of time, and the second will likely decrease (faults due to improper mine shaft backfill, say, are more likely to turn up in the first century than in any one century in the remote future, e.g., during the period 10,000 - 10,100 A.D.). The last two are more difficult to assess, but we argued in the main text (comment on Page 40, bottom, of the Background Report) that #3 should be given at most a secondary consideration. As for #4, if the penetration is "authorized," it is obviously for the authorities of that age to judge the risks. Deliberate "unauthorized" or clandestine removal is again very difficult to evaluate, especially in view of the difficulty of determining an adequate motive. If for terrorism--a common suggestion--the difficulty of clandestinely recovering deeply buried wastes is so disproportionate with respect to what could be accomplished with them that we can only hope that future terrorists will indeed dissipate their efforts on such enterprises.

The preceding arguments are oversimplified in many ways; for example, they neglect environmental behavior after release and neglect the fact that, for the more plausible mechanisms such as water penetration, release itself would be an extremely slow process. Detailed modeling of the relevant phenomena is necessary (results of such modeling to date tend to confirm the conclusion that future risks are very small). It is at least plausible that the release probability per unit time will tend to decrease, not increase. Certainly it is extremely unlikely that the probability of release per unit time could increase sufficiently to compensate for the decay of the hazard potential. Hence, we think there is virtually no likelihood that the risk to distant future generations could be within orders of magnitude of being as large as that accepted by the generation producing the waste, even though all technical estimates show even the latter risk to be very small, as judged by normal societal risks.

Effect of Concentration

In the main text of our Comments, we gave some comparisons between the radiological hazard potentials of man-made wastes and the radiological hazard potentials of natural radionuclides, especially Ra-226, already in the ground. This type of comparison is often attacked on the grounds that the wastes are relatively concentrated, while the radium is very dilute. This fact, however, turns out to make surprisingly little difference for two reasons:

1. Even if moving ground water does reach the wastes and eventually carries some to where human exposure might occur, long-distance migration and long times would be required because of the nature of the site chosen for disposal. By then, decay and dilution would reduce the concentration drastically, and it would make little difference whether the source were initially highly concentrated or not.
2. These comparisons are based upon hazard potentials estimated using the linear dose-response hypothesis (LDRH), which is probably conservative (i.e., overestimates the risks). If LDRH is valid, total hazard potential is proportional to total quantity and independent of concentration. A dilute source corresponds to a proportionately lower risk to an individual exposed to it, but this risk is present over a proportionately larger area and, hence, on the average a proportionately larger population is exposed than for a concentrated source having the same total activity. As a first approximation, these effects cancel out and the total number of people one would expect to be harmed is the same. If this expected number is extremely small, as work by Prof. B. L. Cohen of the University of Pittsburgh suggests (less than 1 person over the next million years for all existing waste), then one cares little whether it is "concentrated" or "dilute" (Cohen 1977). Finally, if LDRH is not valid, the risk is even less, perhaps zero.

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STATEMENT OF VIRGINIA S. ANDERSON, R.N.*

I am unable to attend, but suggest radioactive material waste deposits might be made in the original proving grounds in New Mexico, where, I hear, there are holes as large as or larger than the Empire State Building.

Furthermore, my opinion is that nuclear energy has proved to be not as efficient as hoped, very expensive, and very dangerous.

There are [alternatives that are safer] and, in the long run, cheaper. If the amount of money expended on the alternatives was as much as that spent on nuclear power and for as long a period, we would by now have more advances and cheaper production of solar, wind, or geothermal power.

It is frequently difficult for laymen to get the truth in these matters in our country--let alone what can happen in less responsible governments who are gradually achieving access to radioactive power.

Unfortunately wind and water carry poisons throughout the world. It all becomes a worldwide problem very difficult if not impossible to control.

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STATEMENT OF EDWARD BALLENG

To establish a maximum permissible dose of radiation is at best gross negligence, at worst premeditated murder. An industry that was born out of secrecy, that has been bred by secrecy, and that is maintained with secrecy admits by the process of its actions the dangers inherent in radiation. Recent studies by Dr. Thomas Mancuso, Dr. Thomas Najarian, and Dr. Irwin Bross confirm the deleterious effects of [a] low level of radiation. The government in its part has consistently conspired to block the presentation of these reports.

Dr. Najarian in his study of Portsmouth shipyard employees exposed to radiation found a cancer death rate of more than twice the national average. According to the Boston Globe, the two month study showed cancer death rates for workers exposed to radiation was 38.4 percent, compared [with] 21.7 percent for workers not exposed and 18 percent for the general population. The leukemia death rate of exposed workers was 4 percent, compared to 1 percent for the general population. Deaths from cancer of the lymph glands were 125 percent higher than the national rate. More alarming, though, was the nearly 60 percent death rate of exposed workers between the ages of 60 and 69. This suggests the long germination period of cancer, and the concomitant attitude of benign concern. According to the Boston Globe, which assisted Najarian with his study, the Navy refused cooperation in the study.

While many of us are not shipyard workers or atomic plant workers, the sigh of relief we breathe is upstaged by the work of Dr. Irwin Bross, director of biostatistics at Roswell Park Memorial Cancer Institute in Buffalo, New York. During 9 years of study on the effect of ordinary radiation, Bross found that infants whose parents had been exposed to x rays had a higher rate of genetic damage, and that x rays nearly doubled the rate of leukemia in men. Two months after he presented his report, his grant by the National Cancer Institute was discontinued.

Dr. Thomas Mancuso studied the effect of low-level radiation under the authorization of the AEC. Using population groups from Hanford and Oak Ridge, Dr. Mancuso concluded, "Our findings are that levels of radiation in so-called "safe" areas definitely cause cancer, specific types of cancer. And the findings show that levels much below the safe standards are carcinogenic. This means that low levels of radiation, much below what anyone had recognized before, [are] a common contributing cause toward the development of cancers." [As in the cases of] Najarian and Bross, efforts were made by the government to squelch his findings. The House Commerce Subcommittee on Health and Environment has [looked] and is looking into Mancuso's study and the ordeals that Mancuso has undergone.

I'm sure that this information (as well as much more) that I have presented is well known by you. In the face of increasing scientifically based knowledge on the effects of low-level radiation the only adequate risk assessment is zero release. Until Dr. Mancuso's study on the long-term delayed effects of low level radiation, the biological and genetic effects remained veiled. The fact that the nuclear industry has been and is producing bombs, weapons, and power plants without public accountability and has imposed a radioactive waste problem on future generations robs the nuclear industry of its credibility. At the very least, a moratorium on the production of radioactive waste needs to take place. I accept no standards of acceptable risks from radioactive waste and I resent standards that are "benevolently" determined by others. Zero release and a moratorium present viable alternatives to the present unflinching policy of destruction.

STATEMENT OF JOHN W. BARBEE*

I would like to share my comments with you on the proposed environmental criteria for nuclear waste disposal: I do not believe that economic feasibility should be a mitigator for accepting environmental risk over either the short or long term. This would mean that criteria 3 and 5 as worded are both unacceptable to me. I also feel that we must recognize the cumulative effects of masses of relatively low level radiation wastes under item 2. We must look at both short and long term effects, even beyond 1,000 years. As far as acceptable minimum levels for radioactive contamination is concerned, I believe that the only acceptable level is NONE. Thank you for your attention.

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STATEMENT OF L. BERNATH*

1. Ambiguity of Terms

The proposed criteria are too nebulous, too subject to interpretation, and insufficiently quantitative. For example, "prevent any unnecessary contamination"--how many atoms constitute any? None? What is "necessary contamination"? What is "reasonably achievable"?

Since the "interaction" of wastes with mankind is unstated, how is one to define the "hazardous lifetime" of the waste? If it remains sequestered, is it hazardous? Ever? If it is subject to release, how? How much? When? All need to be quantified to decide whether such release could be hazardous.

Why is it "obvious that unplanned events...are more probable subsequent to lapse of institutional care by virtue of eventual degradation of barriers which provide isolation through natural...barriers"? Once a waste repository is backfilled and sealed, how are natural barriers degraded? If properly sited, e.g., in an arid, seismically stable formation, what events are expected to degrade the "natural barriers"?

How is "equity of risk transference" defined? Isn't this bureaucratic gobble-degook?

What is "a reasonable range of future population sizes and distributions and land, air, water, and mineral resources"?

2. Definition of Radioactive Waste Materials

Material under subsection (b), i.e., natural-occurring, per this definition would have to include flue gas and ash from coal-fired power plants. Is this intended?

3. Definition of Risk from Radioactive Waste Materials

The fundamental shortcoming of the EPA report is the avoidance of attempts to quantify the risks and to establish quantitative criteria to which NRC could apply licensing regulations and DOE could validate (or improve, if necessary) the underlying technology.

Specifically, EPA criteria should recognize the quantitative significance of variations in natural background radiation doses.

For example, the background dose in Colorado is about 200 mrem/yr while that in Connecticut is about 70 mrem/yr. Since there is a factor of 3 difference and since the cancer rate in Colorado is significantly lower than in Connecticut, it should be recognized that there is no detectable risk to the increased dose in Colorado. Thus, EPA criteria should be formulated to permit slight increases in dose to the population in areas of technological implementation of radiation-related activities (industrial, medical, etc.). Perhaps, increases in dose deemed allowable in regions of high background should be less than those in regions of low background. Thus, a 10% increase (200 to 220 mrem per year) would be reasonable in Colorado, while a 300% increase would be acceptable in Connecticut.

The benefits of establishing a quantitative basis for criteria clearly far outweigh the detrimental effect on society of imposing too stringent a cut-off dose rate, such as only allowing an increase of 10% above background.

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STATEMENT OF DAVID D. BILLINGS*

After reading [the Background Report] some major questions remain in my mind. The definition of radioactive waste is, I think, overcomplicated. Any product of mining or processing of radioactive mineral which remains after the usable portion is removed would be waste. If the waste is a hazard to health, then it should be stored in a place where human exposure is, as nearly as practical, impossible for the toxic life of that material. The order of priority would naturally dictate that high-level waste would be isolated first and in the most secure location.

Strong procedures are complicated by lack of knowledge of the health hazards of the waste; unfortunately much of the data on cancer and mutation from radiation exposure has been presented by members of the reactor industry or the pro-reactor ERDA spokesmen. We are told that no one has ever died from a nuclear reactor accident. Fragments of information are reported occasionally, but usually in imprecise form. Such reports have indicated increased thyroid cancer in natives exposed to radiation from the Bikini tests. There have been reports of increased rate of cancer in the Grand Junction [Colorado] area from mill tailings used as foundations for buildings. There are reports of high cancer rate among uranium miners. There is conflicting information as to the contamination of ground east of the Rocky Flats Plant, and data on health hazards from this installation indicate higher cancer rate in its work force.

Based on what we have learned from the long range effects of radiation, the logical procedure would be to cease all mining, milling, and use of radioactive materials until data could be collected that would define precisely the danger from various uses of these materials. Extrapolating from our present information would lead to the conclusion that many people in good health will die prematurely from past exposure to radioactive material.

Massive propaganda warnings that reactors are the only solution to our increased power needs and stating that there has never been a reactor accident have convinced enough of the public to prevent anti-reactor measures from passing. The threat of loss of jobs is always used.

My direct experience with radioactive waste was a one year consulting contract on the classification of atomic waste from the Hanford atomic bomb installation. This short exposure was enough to inform me of the complexity of the disposal of this waste and of the time required for completion of the waste disposal project. My contract has been terminated because of lack of funds. At my last conference with the group working on the glass project, morale was low because of the funding restrictions, blamed on Carter's curtailment of the fast breeder program. The original program called for starting of the glass project in 1985, with completion by early 2000. At the present rate, this timetable seems unlikely.

In my opinion the glass or other methods could be worked out in a reasonable length of time if funds were available to hire people knowledgeable in glass technology. Under the present arrangement, people in the field are reluctant to become involved in a project dominated by people with very limited knowledge of glass and by the red tape of government contract work.

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Based on my experience as listed above, I would want a moratorium on any further reactor building. I am also skeptical of the need for further construction of nuclear weapons. As we do not know the effects of radioactive waste over long periods of time, we should put our present waste into the most chemically stable glass or similar material that can be produced with existing technology. Storage in a geologically inert setting or in an ocean trench appears the best solution with present knowledge.

Based on our handling of the tobacco industry, which is known to kill thousands of people yearly, the outlook for controlling nuclear waste doesn't seem promising. Economic advisers to the federal government are locked into the concept of the necessity for economic growth regardless of the depletion of resources and the loss of health and lives. This concept is popular with most business executives and is the "party line" for the scientists they employ. Until there is a turnaround in this short term thinking, the pressure for an increasing number of atomic energy installations and risky disposal of atomic waste will persist.

STATEMENT OF JACK BRIGGS

The entire thrust of EPA is a bitter disappointment to me and probably to a growing number of Americans who are slowly learning of the true dangers of nuclear radiation. Organized to protect us from environmental hazards, the EPA is now supporting the nuclear establishment in accepting the idea that nuclear power is going to dominate our economy or at least make a major "contribution" to it. This is still questionable. Rather than give credence to the nuclear hazard, EPA should be fighting it tooth and nail to adequately protect the people and environment. Particularly disappointing have been the EPA meetings here and at Albuquerque. They both were predicated upon an acceptance of an untenable nuclear economy (the very antithesis of what EPA should stand for).

The carefully prepared topics are so set up as to make it appear that the "public" participants are also accepting nuclear energy. This is not necessarily the case. Some of us will not accept the idea that nuclear power is necessary. Furthermore, there are growing indications that nuclear reactor programs are failing. We should do all in our power to stop the present nuclear polluting practices which are contaminating our once fair and relatively clean land. We need to stop the radioactivity NOW before the radiation buildup in the atmosphere reaches a point of "no return," so to speak.

The main thrust of this meeting should be to STOP nuclear power.

The secondary thrust should be to stringently regulate and safeguard America from the present abomination of radioactive wastes, not to condone future collections and generation of contamination.

In solving the present waste problem we will be learning how to handle future waste (as best we can), but we should not be anticipating (almost joyfully?) more of the nuclear wastes.

Most specially we should not in any way give aid and comfort to the nuclear profiteers by assuming that a nuclear economy is necessary or inevitable.

Yet this is precisely what this meeting seems to be doing, although EPA's mission should be to stop any polluting devices.

It is to be hoped that the recommendations from this meeting will be to ensure much more careful disposal, transportation, etc. of nuclear wastes than has been effected in the past. The past record is indeed bad. Spills and radioactive releases seem to be on the increase. The inspections, surveillance, and controls must be much tighter and [more] effective--which seems to be EPA's goal.

As Dr. Thomas English (California Institute of Technology) has indicated, EPA's suggestion of adopting a time limit of 1,000 years upon which to base health effect estimates to future people is totally unacceptable, since this approach ignores the potentially catastrophic health consequences to humans after 1,000 years (quoted by permission of Dr. English). As I understand it, this position is not in accord with NEPA goals as published, i.e., "to fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."

A criticism which is hopefully constructive is that the language used is in many cases too "heavy," too bureaucratic and/or technical in terms used. It is difficult for me to

understand without rereading carefully. I am sure that it is difficult for the average "John Q. Citizen" to understand. I'm sure that the concepts etc. can be written more simply and clearly with the result of better communication.

The integrity of reproductive germ cells [is] of course known to be threatened by nuclear-induced mutations.

There is a crucial subject to which the private sector of American science should address itself on the issue of radiation damage to human reproduction.

It is a rather delicate subject one hesitates to mention in a mixed audience but one which must be faced if procreation is to continue normally.

In short, what are the hard facts of radiation effects on penile turgidity?

What scientific research has been done in depth on the radiation effects of this elemental but extremely important male condition upon which human reproduction normally and enjoyably depends?

In other words, are we on the threshold of an era in which Homo sapiens is to depend upon the technology of artificial insemination for his own continuation on this planet?

Independent American scientists are obligated to get at the root of this problem before it is too late to prevent extinction of the human race.

In spite of many dedicated people in the Environmental Protection Agency, it is still the tool of the Jimmy Carter Administration, which is dominated by James Schlesinger, an unemotional radiation-monger devoted to the unwholesome doctrine of Gov. "Pixy" Dixy Lee Ray. Miss Ray, to the detriment of womankind, is urging us to cover this planet with deadly radioactivity (from breeder reactors), while she, spinster-like, overlooks the good breeding necessary for human reproduction.

She even objects to President Carter's feeble and impotent gestures to slow down the catastrophic breeder reactors.

With people in government forcing us to accept a diabolical nuclear fission economy (while propagandizing us with our own tax money), it is clearly evident that independent scientists in the private sector must investigate at once the sensitive but vital matter of radiation effects upon penile turgidity. The urgency is such that this should be done in a crash program beginning today.

STATEMENT OF STEVEN H. BROWN*

As a participant in [the Forum] I would like to take this opportunity to express some observations and opinions which I hope might assist EPA in the development of guidelines by which this critical problem might move toward resolution.

One of the most controversial issues that concerned many participants of the Forum was risk assessment; i.e., what is an acceptable level of risk, and how should it be determined. In the text that follows, allow me to present my own personal views on these matters.

I was particularly concerned and surprised with the lack of acceptance and/or knowledge by many participants of existing risks associated with all forms of energy conversion for electric power generation. Many participants expressed the view that there is something special or unique with the very existence of risks associated with nuclear fuel cycle activities and, in particular, radioactive waste disposal. Along these lines, many participants expressed [that] associated risks as the result of these activities should be literally zero, and effluent releases or the potential for same should also be zero. It is my view that, in the context of man's present activities in the real world, this is an absurdity. EPA, as well as sister Federal agencies (NRC, DOE, etc.), must mutually pursue the resolution of what is an acceptable total risk or an acceptable "price to pay" for present and future generations, in a generic sense as a baseline, regardless of the specific type of energy conversions involved to produce a unit of electric power.

As would be expected and certainly justifiable, many participants were concerned about toxic effects, particularly carcinogenic effects on present and future generations associated with even low levels of chronic exposure to ionizing radiation and radioactive materials. Ignoring all other factors that would be incorporated in a risk assessment and focusing only on "identifiable" toxic effects (in the context of present medical and epidemiological knowledge), i.e., potential health effects to individuals or populations, allow me to discuss similar risks associated with non-nuclear processes for energy generation.

The obvious potentialities for health effects associated with the use of fossil fuels both as the result of routine effluent releases of and/or human exposures to a variety of "toxic materials" are well documented. We are all very familiar with the volumes of federal and state regulations on effluent release limits as well as occupational exposure limits. Carcinogenic effects to coal miners as the result of coal dust exposures (pneumoconiosis), hydrocarbon and organic effluents released during combustion of fossil fuels (CO , NO_x , SO_x , etc.), as well as the release of natural radioactive materials during the burning of petroleum products, coal, natural gas, and even wood all have associated risk functions inherent in them. Naturally occurring radioactive materials, e.g., C-14, K-40, many uranium daughter products, etc., are released into the environment by virtually everyone each day in the processes of heating and lighting our homes, running our automobiles, burning wood in the fireplace, etc. (There [are] even minimal amounts of natural radioactive materials in human excreta.) Radioactive effluent releases associated with these or similar day-to-day human activities can be quantified.

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Assessment of the health risks associated with any fuel cycle should include both occupational health and safety effects, chronic and acute, as well as environmental impacts to populations as the result of effluent releases. Health risks of each fuel cycle could be assessed in the context of these two parameters by subdividing into the following broad categories:

1. Mining or otherwise extracting the raw material from its natural environment.
2. Processing of the raw material into the ultimate fuel product.
3. Transportation of the raw product, intermediate products, and the final fuel product.
4. Activities directly involved in the conversion of the fuel product to commercially available energy.
5. If not directly associated with routine or non-routine effluents associated with each of the above, assessment of risks inherent in waste generation and management of each fuel cycle stage must be separately considered if applicable.

It is my opinion that the Federal government, through the EPA, DOE, NRC, etc., must define for the scientific community and the public at large what is an acceptable level of risk associated with the generation of one unit of electrical power as a probability function. In other words, what would be an acceptable percentage in any population, present or future, of expected health effects as the result of energy production activities. This finite, quantifiable risk should be constant, or at a minimum, consistent for any fuel cycle, nuclear, fossil fuel, or otherwise.

Once this "number" has been established, the scientific and technical community can then proceed to evaluate how much of X can be extracted, how much of Y can be released, how much energy can be produced by a particular fuel cycle economy (all as some function of time) that would result in this acceptable risk.

It is this author's opinion that until this "bottom line" can be quantified, rhetoric, emotionality, and misinformation will continue as insurmountable obstacles impeding the resolution of these most critical societal issues. Definition and implementation of prudent, practical, and acceptable energy policies as they affect the present generation and those to come are paramount to the future of spaceship earth and its inhabitants.

I extend my appreciation to the U.S. EPA for the opportunity to submit these remarks.

STATEMENT* OF FERDINAND H. BURMEISTER†

I am a 44-year old Barton County, Kansas grain farmer who has resided on Barton County farms my entire life except the time spent in college at Fort Mays Kansas State College and at Kansas University and the time spent in the United States Army. I served in the United States Army in Korea during the final months of the Korean conflict and for a few months immediately thereafter, and after this service I completed the requirements for a degree in agriculture from Fort Mays Kansas State College. I reside near Galatia, Kansas with my wife and our three sons.

The construction and use of the proposed Wolf Creek nuclear plant, as well as any other nuclear plant, is objectionable from health, environmental, economic, and moral standpoints.

There are always health dangers in the areas of nuclear energy; if that were not so, why are so many attempts made to safeguard the transportation and disposal of the nuclear waste? Perhaps, then, a person may conclude that such safeguards would eliminate inherent dangers; nevertheless, the risks involved are too great. Unfortunately, all people make mistakes; the most capable, conscientious, and ambitious persons sometimes will cause a blunder. Would anyone be willing to handle nuclear material if he suddenly became aware that it had been placed into the wrong facility? And, even in situations where the radioactive material is handled strictly according to plans, does anyone wish to dwell or spend the greater part of his life near it? Surely nobody wants the radiation-induced cancer and genetic defects that could develop from this radiation.

The detrimental effects on the environment by the use of nuclear power must not be overlooked, both from the standpoint of the aesthetic value of the environment and the practical use of the environment. Promoters of nuclear power plants often make the misleading argument that such plants do not pollute the atmosphere as do conventional coal-burning or oil-burning plants; the truth is that nuclear power plants do not create the same kind of pollution that fossil-fuel plants create but they do intensify an existing form of pollution--thermal--and in addition present a dangerous new form of pollution--radioactive. Why, then, should we be willing to sacrifice scenic splendors such as Pike's Peak and the Appalachian Mountains, to strip mountains for the tiny fraction of concentrated energy which they contain?

The use of nuclear energy at first appeared to show promise of being economical and abundant, but technology has not been sufficient to bring these conditions into existence. Experience now clearly shows that nuclear plants are at least twenty percent costlier to construct than conventional plants of equal generating capacity. And it has been estimated that after the operating life of a plant (expected to be only thirty years), the initial entombment of one large plant would cost \$900,000 and that an additional \$300,000 would be spent annually thereafter for maintenance through the years and centuries. Do we want to place this financial burden upon our children and our children's children?

*Originally presented at evidentiary hearings pertaining to proposed Wolf Creek Generating Station, Unit No. 1 (held at Coffey County Courthouse, Burlington, Kansas, 12 November 1975). Docket No. STN 50-482.

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The grave moral issue involved in the Wolf Creek power plant proposal consists of the infringements on the personal rights and property rights of individuals and private establishments. The intent of the founding fathers of our Federal government and our state government of Kansas was that people and private establishments have a right to obtain, maintain, and retain their property as long as this right did not interfere with the rights of other parties. However, that privilege has been abused time and time again as land and other property has been yielded by its owners involuntarily for various projects; this abuse has occurred so often that society tends more and more to become unconcerned about the implications, particularly that segment of society which is not adversely affected. Nevertheless, might does not necessarily make right, the wishes of the majority are not necessarily best for any society, and the rights of the minority must be protected. Additionally, the reduction in the amount of productive farm land is always inadvisable and is particularly inadvisable now in a time of excessive demand for food throughout the world. Sentiment has been pushed to the background in this particular case as in so many other cases, particularly in recent years; unfortunately, the prevailing attitude has tended to be, in reference to confiscated property, "If they are paid for it, they have no right to complain." Such an idea overlooks the awareness of things that money cannot buy. Should not a law-abiding citizen have a desire to retain his farm or other property, even if only for sentimental reasons? How many people are willing to exchange their wedding ring or other personal jewelry for comparable items of equal market value or even greater market value? Economics also enters into the matter of property condemnation. Whenever anyone must move his residence or business to a new location, many financial losses and other difficulties occur which often are overlooked by others. The financial compensation for the property may be less than could be obtained elsewhere, and there are the expenses involved in moving and relocating; often there is great difficulty in finding suitable property elsewhere, and in many cases one chooses a new location which is only partially suitable.

In stating my position I have shown the negative aspects of the plant proposal; I now briefly present positive alternatives.

We in the United States, Kansas, and the Burlington area are able to reduce the amount of energy used in forms such as electricity; nevertheless, we can expect to use it considerably in the future. Some alternative sources of energy are quite easily available and are more economical than nuclear energy. Because of the actual high cost of nuclear power, certainly no definite proof has been made regarding its economic competitiveness with fossil fuels. Coal is available in this country and therefore could be used considerably as a source of energy in this area or elsewhere. The use of solar energy (including wind energy) is showing great promises. One certain publicly held company in Colorado manufactures and markets a complete solar space heating system, and this heating system has been installed on numerous buildings since 1944. Such a system is expected to have as long a life as the building itself, without any maintenance costs. Such a system meets or exceeds the performance criteria -- for solar -- developed by the National Bureau of Standards for the Department of Housing and Urban Development under the Federal Solar Heating and Cooling Demonstration Act of 1974. And wind power is highly desirable when absence of pollution is included in efficiency ratings. For years many farmers depended on wind-driven mills to pump their supply of water, and during the past many farms had small wind generators which produced electricity. Opportunity for a much greater production of electricity through the use of wind generators appears encouraging; if as much financial support -- public and/or private -- would have been provided for research in solar energy as in nuclear energy, it is entirely possible that by this time solar heating systems would have been as prevalent as other heating systems and large wind generators would have been as common as radio and television stations. Could not all of us benefit from the

greater use of the sun and the wind for these purposes? Why can't we, why don't we, make greater use of such resources as these, such resources which are available to all, such resources on which no one in the area would have a monopoly or special advantage?

In closing, I wish to emphasize that I formed my above opinions on the basis of my background experience, studies, and observation; I studied the various sides of the issue with an open mind; I have not been swayed by any emotions, by any glitter, by any promises. I have kept in mind the needs of all people as consumers, and I remain aware that I too am a consumer and that all of us consumers want and need energy. I have kept in mind the environment; I want the various facets of our environment to be preserved as much as possible. I strongly demand that no segment of our environment be completely eliminated or unnecessarily damaged; however, if necessary I am willing to accept some sacrifices of the beauties of nature in order to provide a higher standard of living for mankind. I have no vested interest in the Wolf Creek proposal; I have no agricultural connections in the Burlington area, and I am not associated financially with production of nuclear power plants or with production of solar energy systems. I have not wanted any financial payment for taking any position on this issue; neither have I been offered any such payment. As a concerned citizen, for this issue I have chosen to support firmly and without reservation the most mutually beneficial position for the citizens of the Wolf Creek area, the surrounding areas of Kansas, and beyond Kansas; I therefore stand opposed to the installation and use of the proposed Wolf Creek nuclear power plant in the Burlington, Kansas area.

STATEMENT OF PAUL BURMEISTER*

I attended [the Forum], where I participated as a member of Working Group II, which dealt with the question, "What are the characteristics of an adequate risk assessment and of acceptable risks from radioactive wastes?."

With this writing I would like to make some comments concerning some of the contents of the EPA Background Report, "Considerations of Environmental Protection Criteria for Radioactive Waste" (February 1978), the "Issues for Discussion by the Working Groups," and statements made at the Forum.

On page 12 of the Background Report, first paragraph, it is stated that the cost of control technologies is an important consideration "in determining management of these materials;" and Item 6 of the Working Group II agenda was "Risks due to radioactive wastes should be unacceptable unless more complete isolation is unreasonable in view of technical, economic, and social considerations." Since it is known that the billions of curies of existing radioactive wastes and any prospective wastes must not under any circumstances be released into the biosphere, in my view it is not appropriate to give economic considerations high priority in determining whether or not more complete isolation of radioactive wastes is unreasonable. Since the problem is so critical, the long-term health of mankind and the biosphere being at stake, if necessary great economic investments should be made to reduce the risks due to radioactive wastes.

On page 14 of the Background Report it is pointed out that prohibiting their production is the only way to guarantee absolute protection from pollutants such as radioactive materials, which are assumed to have no threshold for effects. I feel it is important for EPA always to keep this fact in consideration.

Near the top of page 17 of the Background Report it is stated, "Any potential risks should also be no greater than those acceptable to the producers, and preferably should be less in view of the unavoidably greater uncertainties in risk determination for the long term." I respond in saying that much should be done to make arrangements such that the risks to future generations, from the nuclear fission technology by which possibly only our generation will receive any benefit, will be much less than we impose on our own generation. I certainly believe that we of our generation have no right to force future generations to live under new, unnatural risks to which the public was not exposed only thirty-five or forty years ago.

On page 18 of the Background Report, paragraph 2, it is stated, "...it still remains to be decided how far into the future responsibility should extend." I believe an ethical approach is one in which it is assumed that man and other living things will continue having basically the same physiologic designs, habits, and traits for an indefinite number of hundreds of thousands of years into the future, as they have continued the past thousands of years (according to my understanding, remains of human-type organisms which seem to be one to three millions of years old have been uncovered in Africa); and that responsibility should extend for as long as the radionuclides generated or uncovered through man's activities are projected to be a serious biological hazard. I do not see what right mankind has to use any approach less conservative, which applies a time-frame shorter than this.

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At the Forum, one view was presented that future people either might or might not have superior technology and medicine. In my view, if the future people would have superior technology, it might turn out to be a technology in which they were not adapted for dealing with this particular problem of producing, detecting, and handling radioactive wastes which generally cannot be detected with the human senses alone. I believe the criteria should be based on the assumption that the survival and health of future people and other living things should not be made to depend upon the use of special equipment harmful radioactive substances in the environment.

Concerning superior medicine, I ask how the superior medicine would be applied to the various non-human forms of living things which keep the biosphere balanced for all.

Concerning the last paragraph of page 40 of the Background Report, I do not agree that, "...consideration need not be devoted to designing against major disruptions of waste by ... nuclear war, ice ages, or comparable cataclysms." I believe it is important to design against disruptions of radioactive waste by war, which disruptions, I believe, could be extremely harmful even when compared to other forms of disruption by the war. An ice age might cause an area to be unlivable for a time which could be short relative to the hazardous life of the radioactive waste which could spread to other areas of the world biosphere following its exposure.

Item 8 of the Working Group II agenda says for consideration, "Certain risks due to radioactive waste should be considered unacceptable. These would be associated with circumstances in which:

- a. any exposure having a high probability of occurrence could result in more than a chronic risk which could not be further reduced by reasonable controls."

It seems quite possible that a "chronic risk," itself, could turn out to be very unacceptable.

- b. "the levels of any chronic risks are not less than those for comparable high probability circumstances acceptable to society, or"

I believe we should work to prevent adding any serious new, unnatural risks to the somatic and genetic health of man and the biosphere, even if it might appear that the level of that risk is somewhat less than the level of some other risk.

- c. "high-consequence events do not have a probability of occurrence less than that for comparable high-consequence events accepted by society for similar productive technologies."

In the near future, society could decide that the previously accepted risks of certain high-consequence events are unacceptable. Also, I question the implication that there is any productive technology which produces a product similar to radioactive wastes. High-consequence events of radioactive waste storage or disposal would probably have much longer lasting effects on the somatic and genetic health of man and other living thing than would events of most other technologies, since the damaging effects of radioactive wastes, which when dispersed appear to be irretrievable, are determined by the instability of the atoms themselves, which instability becomes reduced only by "decay" over a preset length of time, as compared to nonradioactive waste products, many of which are molecular in makeup and eventually "break down" in time, and which generally require intake of larger amounts to be harmful to health.

Concerning "passive methods of communicating to future people the potential hazards which could result from an accidental or intention disturbance of radioactive wastes" (page 53 of the Background Report), I question an assumption that future people would be able to interpret the information as originally communicated.

In my opinion some of the views in the Background Report seem to be too anthropocentric; that is, there is a lack of discussion on the potential risks from radioactive wastes to plant and animal life, including the accumulation of certain radionuclides in some food chains. When comparing the effects of radioactivity from artificially produced wastes with natural background radioactivity, it seems to be very important to consider the kinds of radionuclides involved. An important fact is that certain fission products and actinides tend to be concentrated by the biosphere, concentration factors of 10^5 - 10^6 being not unusual. Estimates of radionuclides' sequestration in the biosphere should be made and applied for determining risks associated with radioactive wastes.

In the glossary on page 54 of the Background Report, in the definitions of "institutional controls" and "isolation, radioactive waste," is the phrase, "contact between the waste and the human environment." I suggest that the goal of controls and isolation should be to prevent contact between the waste and the "life environment" or "biosphere" and not only the "human environment."

I have wondered whether, perhaps, the waste should be stored deep underground in strong containers (if suitable containers can be made) in a retrievable condition and position for some decades or longer while a great deal of research is done in finding improved methods of disposal. For example, it may be possible that a safe, technically and economically feasible way to dispose of the existing radioactive wastes extraterrestrially, such as placement around the sun or into the sun, could be developed. Or possibly methods of terrestrial disposal safer than those which have been tried up to this time can be developed for the existing wastes.

I am appreciative of the work that the EPA is doing in developing environmental protection criteria for radioactive waste. In my opinion the EPA Background Report contains many useful, important suggestions and conclusions (for example, on page 32, the implication that, because of the long-term persistence of the potential hazards presented by radioactive wastes, "most of the people potentially at risk are not yet born;" and on page 22, "...the goal for control of radioactive wastes should be to prevent its introduction into the biosphere over its hazardous lifetime").

I thank you very much for your attention to these matters.

STATEMENT OF DR. GEORGE I. J. DIXON*

[Comments (submitted to Wisconsin Public Service Commission and to EPA) on utilities' Advance Plans]:

My statement deals with a significant economic and safety problem completely omitted from the Advance Plans of the electric utilities. This problem can be expected to increase considerably if more nuclear power plants are built. I believe it essential that the Public Service Commission study the condition deeply, for it involves both the safety and economic interest of Wisconsin citizens.

I refer to the storage of nuclear wastes in Wisconsin, although not to the deep geologic storage of reprocessed wastes at some possible Wisconsin site proposed recently by the U.S. Energy Research and Development Agency (ERDA) which aroused such immediate and vehement objections from state legislators and officials and has led to a flurry of resolutions against any such permanent "storage" plans. The Town of Rudolph led the way in passing a resolution against the storage and transportation of such wastes in Wisconsin. I refer to the real waste storage problem: what to do with highly radioactive spent fuel from reactors is precisely a result of the growing uncertainty that either reprocessing or any permanent waste disposal method will be developed or approved in the foreseeable future.

[The Wisconsin Public Service Commission] has already recognized that spent-fuel storage at the reactor sites constitutes an economic burden to Wisconsin rate-payers. A rate increase granted WEPCO on Aug. 5, 1976 was necessitated in part by expansion of the spent-fuel storage pool to accommodate radiated fuel rods since no reprocessing plant is ready to handle them. Commissioner Matthew Holden objected to the increase, stating that he believed it was "a violation of the cost-of-service principle to assign the extra costs of nuclear fuel storage to the rate-payers...50 percent of the total electric increase granted here is attributable to added costs storing spent or used nuclear fuel, and these costs had not been anticipated or brought before the Commission at any previous proceedings. These are, if one may say so, surprise costs." (State of Wisconsin Office of Emergency Energy Assistance, 3rd Quarter Report, Oct. 1, 1976). These costs are still not being "anticipated or brought before the Commission" in the Advance Plans under discussion.

However, there can be no question now that the utilities MUST anticipate a multiplication of these costs which are passed on to the consumer. The plans were clearly stated by Victor Gilinsky, Commissioner of the U.S. Nuclear Regulatory Commission (NRC) in testimony before the California Energy Resources Conservation and Development Commission Informational Hearing on Nuclear Fuel Reprocessing and Waste Disposal at Sacramento, Jan. 31, 1977 (U.S. Nuclear Regulatory Commission News Releases, Vol. 3, No. 4, Week Ending Feb. 2, 1977).

Future rate increases to further expand pools at existing or planned reactors in Wisconsin are a certainty. Already the pools at Genoa and Point Beach have been approximately doubled. And although the pool at the Kewaunee plant presently contains the used fuel rods from only one refueling, the NRC has asked the utility to plan to expand storage capacity. Gilinsky states pools are designed "...large enough to store the spent fuel output for about five years of operation." The reason for this premature

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expansion at Kewaunee may be explained by a possibility stated by Mr. Gilinsky that "a considerable amount of shipment from sites with overflow to sites with excess capacity" may be necessary. Will the planned expansion of the Kewaunee spent fuel pool be used to store nuclear wastes from other plants in, or out of the state?

Mr. Gilinsky's conclusion is that by 1985 pools at reactors will be expanded to capacity. What then? He states: "A question that ought to be on everyone's mind by now is what will happen if neither reprocessing nor a repository materializes by 1985? The answer must be continued interim storage in pools" (my underscore). Where? ERDA gave the answer in May, 1976: "Independent pools, not associated with any other nuclear facility, have been proposed to alleviate the lack of storage space for fuel presently being discharged from operating nuclear power stations, but for which storage capacity is rapidly diminishing" (ERDA, 76-43, Vol. 1, p. 2.28). Will continued production of nuclear wastes from Wisconsin reactors necessitate such "independent pools" at other Wisconsin sites which rate-payers will finance?

How long will nuclear wastes be stored at spent-fuel pools? No one knows for sure. Commissioner Gilinsky admits 20 years or more. A utility representative commented informally a few weeks ago that he wasn't worried about the nuclear waste because it can be stored at the plant for 200 years. However, Mr. Gilinsky admits there is no experience with storing spent fuel in pools for more than 10 years--"relative lack of published information" will necessitate "further study" to determine "that it is safe to let spent fuel assemblies sit in pools, perhaps for as long as 20 or more years."

The problem of safety arises from increased radiation to the atmosphere from pools as well as the hazard of accident. The NRC Regulatory Guide (4.2, Rev. 2--Preparation of Environmental Reports for Nuclear Power Stations, July 1976) lists the fuel pool water as a source of "releases of radioactive materials in gaseous effluents due to evaporation" and requires utilities to assess the potential radiation dose to the public from several possible "spent-fuel handling accidents."

A recent ERDA study (ERDA 76-43 - Alternatives for Managing Wastes from Reactors and Post-Fission Operations in the LWR Fuel Cycle, May 1976) explains that "Pools will be a source of both wet and dry solid wastes that will require shipping, storage and associated management operations" (p. 2.28). In fact, since "short-lived isotopes have decayed before fuel is introduced to the pool (at a reprocessing center), the chance of radioactive contamination is less than at the reactor pools" (p. 2.39). This "fresh" radioactive waste in spent fuel assemblies "will have a beta-gamma radiation dose rate at discharge of more than 10,000,000 Roentgen/hour (R/hr) at the most radioactive surface" (p. 2.34). In fact, "about 200 times the amount of uranium and plutonium normally expected in the high-level waste (from recycling) would be discarded with the spent fuel assemblies" (p. 1.2).

In our neighboring state of Minnesota, citizens are much more aware of the hazards of continual storage of wastes in fuel pools. The Minnesota Pollution Control Agency and Northern Thunder (Eau Claire, Wisconsin) have petitioned to intervene at NRC hearings on the proposal that the Prairie Island reactor be allowed to store $3\frac{1}{2}$ times as many spent fuel assemblies in the storage pool as the pool was originally designed to accommodate. The spent fuel would be crowded so close that it would be within a 5 percent margin of a condition of criticality--setting off a chain reaction and a resultant runaway reactor. Minnesota citizens point out that "irradiated fuel storage pools at Monticello contain an estimated 33,800,000 Curies. Having *de facto* high-level radioactivity storage areas at these two Mississippi River sites near the Twin Cities raises a number of questions relating to public health and safety. Of the 484 fuel bundles in the

Monticello pool, "...237 are known to contain leaking fuel rods. How radioactive is the water that cools these highly contaminated leaking fuel rods? What levels of radioactivity enter the atmosphere from such spent fuel storage pools? Are any of these pools leaking to the ground water whose direction is to the Mississippi River? Is this a threat to the integrity of the water supply of the Twin Cities?" (from statement to Minnesota Control Agency from representatives of Northern Environmental Council, Friends of the Earth, Clear Air Clear Water Unlimited, and Minnesota Environmental Control Citizens Association, October 26, 1976).

Wisconsin citizens should be aware of these hazards which are directly upwind on the Mississippi River. Because of the problems with fuel cladding defects at Point Beach, many of the fuel rods, which rate-payers are paying to store there, are leaking into the cooling water and the atmosphere.

State officials have responded with anger to the Federal proposals to store nuclear wastes in geologic sites in the state. But no state official has intervened in the expansion of waste storage AT PRESENT REACTORS in the state, nor have they asked the utilities to make clear their plans for the capacity and the radiation dose from future nuclear plants. NRC Commissioner Gilinsky states that the NRC may be "entitled to require augmentation by the industry of spent-fuel storage capacity." However, he does suggest that all states might not accede to such requirements: "Will the states, in exercising their own responsibilities, be content to leave the matter in the hands of the power companies?" I hope not.

I believe it is within the province of the Public Service Commission to require the utilities to outline now the economics and safety of predictable continued augmentation of waste storage in spent-fuel pools.

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Wisconsin Office of Emergency Energy Assistance 3rd Quarter Report, October 1, 1976.

STATEMENT OF THE DOW CHEMICAL COMPANY*

Please let the record show that The Dow Chemical Company wishes to comment on the establishment of criteria for radioactive waste.

To set protection criteria for radioactive waste it is necessary to define "radioactive": precedence has been set by the Department of Transportation as defined by Title 49, Code of Federal Regulations, Part 173.389, Radioactive Materials, definitions, (5), (e), and would appear appropriate. The regulation reads as follows:

- (e) "Radioactive material" means any material, or combination of materials, which spontaneously emits ionizing radiation. Materials in which the estimated specific activity is not greater than 0.002 microcuries per gram of material, and in which the radioactivity is essentially uniformly distributed, are not considered to be radioactive materials.

In Nuclear Regulatory Commission licensed facilities the licensee should determine what is or is not waste. This determination need not be reviewed by a regulatory agency other than during the periodic license auditing process.

Technologically enhanced radioactive materials which reach the definition of "radioactive material" should be treated as such by the producer of the material.

Before disposal (meaning no recovery) be done we suggest that "radioactive wastes" be segregated into categories based on specific activity, half-life of radionuclides, and toxicity of radionuclides. Disposal is probably necessary for some radioactive wastes but must be done with care. All "radioactive waste" need not and should not be treated the same. Spent fuel rods are so valuable, future generations will probably want to retrieve unprocessed fuel rods as an example.

In choosing where to begin, control of individual doses should be a key to risk assessment. Controlling population doses by controlling individual doses to a risk level which is comparable to background risk levels is a basis for establishing a reasonable radioactive waste policy.

Pre-existing criteria for the population regarding radioactive material now exist. These are adequate in that they are well below background levels in most instances; see Title 10, Code of Federal Regulations, part 20, Appendix B, Table 2. There is no evidence to show that these limits have any detrimental effect on man and his environment.

Zero risk and complete safety are impossible to achieve in society. There should be consistent risk criteria applied to radioactive material and non-radioactive material based on scientific data not prejudices of a few uninformed.

*Received from R. R. Langner, Director, and D. L. Barsten, Health Physicist, U.S. Area Industrial Hygiene, Dow Chemical Company.

STATEMENT OF THERESA ERICKSON, PAUL FRANK, JOAN SCHAUM, PETER
ALPERT, JEFF TRACY, AND C. B. PEARSON

We would like to be recorded as supporting the Fourth Report [pp. 139-142, this volume] submitted by those opposed to the continued manufacturing of radioactive wastes. This continued manufacturing of radioactive wastes in lethal doses seems to be leading us on a course of self-destruction without adequate knowledge of nuclear waste disposal. We feel that EPA is rushing headlong into setting criteria without considering the consequences. The hypocrisy of the present scientific data on radioactive wastes leads one to doubt the present risk that we are subjected to even though some call it necessary (i.e., Sen. Paul Rogers' efforts). The establishment of criteria does not insure safe and persistent disposal. The present day American attitude of out of sight out of mind, we fear, will tend to carry over into the disposal of radioactive wastes. Can EPA permit this to happen?

To say that this information that we so diligently worked on is going to be used in the final preparation of disposal of radioactive waste is for us to believe that the maze of bureaucratic agencies will not reflect their own bias and that of the industry. For example, the present situation with the NRC is like letting the fox watch the chickens, like making a turnkey put his own son in jail.

We feel that the EPA is responsible for the induction of many more public hearings for the public to participate in this most important decision. EPA should also be responsible for "cluing the public in" on the process under which these decisions are maintained, implemented, regulated, and enforced. What impact does public opinion truly have?

The bare truth is that the three national meetings held on the management of nuclear waste disposal is hardly a conclusive feeling of the public pulse. We urge the EPA to expand the scope of their hearings to include the PUBLIC. This means holding meetings at times and in places that are comfortable and accessible to the common public. As Einstein said, "Nuclear power and all it implies should be debated from every public square before the uses for nuclear power are decided upon."

STATEMENT OF FREDERICK FORSCHER*

This letter points out two aspects of nuclear waste that have not been brought out during any of the workshop sessions, but which must be seriously considered in the formulation of criteria and standards. These new aspects are: military considerations, and the potential benefits of nuclear waste (as an energy source). I am an independent energy consultant, strongly pro-environment but not anti-nuclear, who has attended all three EPA Forums (Reston, Virginia; Albuquerque, New Mexico; and Denver, Colorado) and the preceding EPA/ERDA/NSF/etc. meeting in Chicago. The comments are arranged and discussed under the Topics as presented at the Denver meeting.

Topic 1: What is Radioactive Waste?

Comment: The rubble, debris, etc, resulting from a nuclear explosion must be included in the contemplated definition of radioactive waste to be covered by disposal criteria.

Discussion. True, the generic definition covers this type of waste. However, I feel strongly that bomb waste should be specifically called out, as are waste reprocessing, mine tailings, medical waste, etc. By including this waste into consideration of criteria development and waste management, one puts a completely new perspective on the probability of generating nuclear waste, on the volume of waste to be disposed, and on the location where it may be found.

Topic 2: What are the Characteristics of an Adequate Risk Assessment?

Comment: In view of the real, and possibly imminent, risk of severe damage by nuclear bombs (nuclear explosive devices), it makes absolutely no sense to estimate the health effects of waste disposal schemes for 1,000 years or longer. If we have to use a time limitation I would suggest 50 years.

Discussion. I remember the German enthusiasm to design the Third Reich for 1,000 years. Our anti-nuclear groups show the same enthusiasm to rid the world of nuclear menace. But hopes or fears are poor guideposts toward rational criteria. Introducing military considerations puts a new perspective on the subject of risk assessment.

True, everybody is against war, particularly nuclear war. But, closing down Rocky Flats will not stop the Russians. Anti-nuclear and anti-war groups must address the question of what constitutes an "adequate national defense." This is a constitutional responsibility of the Federal government. Wishing away all nuclear explosives does not substitute for real and present Federal responsibility.

It is disappointing to hear Congressional testimony by David Hawkins, Assistant Administrator for Air and Waste Management, EPA (March 22, 1978) to the effect that "risk estimates are to be the primary determinates for decision; these should be performed for human individuals and populations for at least one thousand years on an absolute basis... ."

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Topic 2: What are Acceptable Risks from Radioactive Waste?

Comment: Acceptability implies that the perceived benefits outweigh the perceived risks. Hence, there is no way to discuss acceptability without entering the debate of real or perceived "benefits" of nuclear waste.

Discussion. It is heresy today to claim that high-level waste, per se, has benefits to us and future generations. Yet, there is no doubt that nuclear waste represents a unique source of energy. In an energy-short world, no source of energy should be considered useless or a waste. I would like to consider it as "boxed sunshine." If we ever are faced by an epidemic of bacterial origin (e.g., Legionnaire's disease) nuclear waste will be godsent for water purification and sewage sterilization.

The benefits of the reactor-generated plutonium for present and future power generation have been discussed. Safeguards must be provided to prevent this valuable material [from being] used for malevolent use. Safeguards can be considered to represent a new protective institution of society of the same dimension as law enforcement, or fire protection. Many capable organizations are now developing this new institution, both on a national and international scale. The idea is to establish a viable fire protection instead of searching for ways to eliminate flammable materials.

STATEMENT OF NINA HERSH*

[I participated in the Forum], although because no child care had be arranged for participants [I] was able to attend only one day and one night session. I wish now to put in writing my emphatic views that large segments of the public, particularly those who are really aware of the issues, are not willing to accept the risks posed by continued production of radioactive wastes. Of course I realize that the existing ones will have to be disposed of in some way; there no expense should be spared as it is not only ourselves but future generations we are endangering. But for God's sake let's quit making the stuff unless and until we have much more extensive genetic information and evidence on its effects, and unless and until we find a truly safe way to dispose of it. The expression "isolating the wastes from the biosphere" was bandied about at the conference. That's what we have, that's what they gave us to live on and work with; that's what the materials and people are from and part of, and it is difficult for me to comprehend how it can be isolated from it. (I don't consider shooting the stuff in rockets toward the sun a reasonable alternative, if that's what people have in mind as getting the wastes away from the biosphere.) I have been doing some rather serious study of the nuclear issue for the last few months, and am horrified at the arrogant and callous attitude displayed by the industry representatives at [the Forum] in light of what is now known. Not to mention that it seems that every increment in knowledge we have about the effects of radiation on people and their enviroment seems to show that the potential for damage is worse than ever contemplated.

I consider the past actions of this government irresponsible, to say the least, when we continued to produce these hazardous substances without real understanding of what harm they might do and no clear ideas about how to get rid of the wastes. To continue their production with the clearer understandings we now have of the dangers is totally reprehensible. If there are any future generations I expect they will judge us in the harshest terms.

It is my understanding that the Enviromental Protection Agency is charged by Congress with the task of protecting the enviroment. Therefore I cannot comprehend why, in light of the clear and known dangers that result from the production of radioactive materials, the EPA itself has not taken a firm stand against their continued production.

Truly, I believe if a massive education program were undertaken in this country (How about by EPA?) as was done in Sweden, ther would be such a massive outcry on the subject that nuclear facilities would come to a screeching halt.

Yours for a healthy and safe world, with a tiny bit of hope that the right people may listen.

*2505 Juniper Avenue, Boulder, Colorado

STATEMENT OF MARY HEY*

Because I have a small child, I was unable to attend [the Forum]. So I thought I perhaps might write a few words for consideration and say to you what I would have said had I been there.

Living so close to the Rocky Flats Nuclear Weapons Facility, the danger of nuclear by-products is in my mind a great deal. When I take a walk I wonder about the air and which day it will be that an accident at Rocky Flats will belch particulate plutonium in it. When I see my daughter carefully inspect a clod of dirt and pop it into her mouth (one-year-olds have very catholic tastes), I wonder about the "acceptable" levels of plutonium in our soil, levels that become more conservative as the years go by. And I wonder about that single particle of radioactive dust that is known to cause cancer and if and when it will find its way into the miraculous little body that I spend my days caring for, unseen.

I have worked in enough places (government, private enterprise) to notice how decisions are made, how the appearance of full control, of complete understanding becomes far more important than the reality. I have also seen people make mistakes that they have sworn were impossible, myself included. Given the nature of radioactive waste and its longevity, the pretense of control is madness. Yet the stuff exists, and we must deal with it.

The least we can do for ourselves and our children, and the children beyond, is to ask for the tightest controls possible. Or even more heroic, to demand standards that are impossible to meet in order to squeeze tight the valve of poison that our arrogance has allowed to open. Please have the courage to stand up to the powerful, short-sighted interests that seek only to protect their investments and establish criteria on the basis of human life and its future only.

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STATEMENT OF MARY HUBBARD*

I attended [the Forum] and I learned so much that I wanted to let you know how I feel about the nuclear industry.

That radiation in any dosage is dangerous is well documented. Living in Denver I feel a threat from Rock Flats to the millions of people who live here. They have had over 200 plutonium-related fires in RFP, releasing much of the dangerous substance into environment. I think it's unconstitutional and inhumane to expose anyone to radiation without their knowledge and consent. I don't think most people would want to accept the risk if give the choice. I'd like to see the nuclear industry admit its errors of the past, close down, and spend all that money instead on cleaning up the mess and developing alternate safe power sources. Solar technology could safely light us up for 7 billion years. On the other hand nuclear technology poses such a dangerous threat to all life force on the planet. I pray daily that we can come to a global disarmament which would take us a step closer to true Peace on Earth.

I think the conference was not well publicized for the importance of the subject. For people to make clear decisions on the nuclear issue they must have access to much more information (that is factual evidence to support both points of view). I think the media up until now has been and is heavily pro-industry slanted. I'd like to see more real scientific data about effects of radiation on life [and more] radiation emission checks and from that make moral decisions about how to protect all life.

We have a man living with us who worked in uranium mines for eight years with absolutely no protection against the heavy exposure he had daily. At one time he took some of the hot rock home and had it on his bedside table. He had to shift to the coal mines when he got sick with emphysema. He now has multiple sclerosis fifteen years later. He has very little control over his body so he is bed and wheelchair bound. We are only beginning to understand why he is so sick. We love him a lot and pray for miracles with him.

I know your job is not particularly easy. It's hard to be objective about a subject which is so controversial. I know you can all be strong and make decisions on the basis of moral principles that will hold true for our children's children and on.

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STATEMENT OF JUDITH HURLEY*

The greening of earth in spring. Water flowing. My cat's ear tufts and three (only three) eyebrow hairs. The fragrance of hyacinths when you get down close to the ground. My very young friend Emily whose only word is "Hi" (she says "hi" to concrete walls and to peanuts as well as to me).

There is nothing abstract about what I love and seek to protect. That there should be anything--at all--is so dazzlingly unlikely that I have spent half my life simply marvelling at being. And that on this round rock there should be life--there should be me, there should be Emily, to say "Hi" and to smell the hyacinths is what you must keep before your minds' eyes all the time.

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STATEMENT OF ROGER E. KASPERSON, ROBERT W. KATES, AND BONNIE BRAINE

General

As the [Background Report] indicates, there exists a substantial divergence between "expert" and "public" opinion in risk acceptability for the nuclear fuel cycle. Continuing public reaction to the transport and storage of nuclear wastes, experimental psychological research (Fischhoff, 1976), and a series of analyses of public attitudes (Maynard et al., 1976; Brooks, 1976) suggest that the risk of nuclear energy have attributes particularly feared by the public, such as their catastrophic potential and the fact that radiation is invisible and results in a dreaded disease (cancer). Radioactive waste management may well prove to be the most sensitive of all the "nuclear" issues in terms of public acceptability: existing wastes provide no direct benefits to future generations, and few perceived benefits to the present population. Furthermore, nuclear power has become, for many, a symbol of the negative aspects of centralized, government-sponsored technology, and of decision making processes with little allowance for public decision. It is clear that extraordinary public consultation and participation will be required to create a waste management policy acceptable both to the nation and the affected localities.

Specific Comments on the Proposed Criteria

1. An adequate risk assessment should consider not only health effects, but also the social-psychological impacts of waste management activities. Fear is a very real cost in radioactive waste management, and will affect public acceptance of government programs. The criteria eventually adopted by the Environmental Protection Agency should acknowledge the perceived as well as the simulated (statistical) risks associated with radioactive wastes. Although perceived risk factors cannot easily be factored into risk criteria, what is already known about public perception of nuclear risk argues for a different position than that taken by the Background Report. Risk criteria for nuclear waste management, to be acceptable to the public, will likely require greater stringency than those in other technological areas.
2. The Background Report does well in seeking to limit the use of institutional controls. To be publicly acceptable, reliance on institutional controls should be minimized whenever possible, and primary reliance instead placed on engineered and natural barriers to protect the public. The period employed for institutional controls should not exceed 100 years and should probably be less.
3. The use of 1,000 years as an outer limit for the performance of detailed risk assessments will imply that sufficient attention has not been directed to specific waste categories and storage options. Widespread public concern is focused on long-lived isotopes. Risk estimates should be projected for the length of time necessary to determine the most effective disposal technique for the particular type of waste under consideration. In the case of uranium mill tailings, for example, adverse effects should be calculated for the lifetime of the exposure hazard, which is defined in the Background Report as the half-life of thorium-230, or 80,000 years. The inability to perform detailed risk assessments of human health effects beyond a certain time should not be a limiting factor in extending the analysis.
4. As a general principle, risks within a given population (present or future) should not be distributed inequitably unless this is done in relation to concentrated benefits.

Concentration of potential hazards will occur, however, due to the location of storage areas, transportation corridors, and long-term repositories. Therefore, standards should be developed that are as stringent as possible to minimize exposure risks in site- and corridor-specific areas. Regions with high background radiation levels and/or pre-existing radiation hazards (such as sites or structures previously contaminated with uranium mill tailings) should not be selected for storage of radioactive wastes. And site locations should be chosen with a view to minimize transport corridor exposure.

5. Risks to future populations should be less than those to the present, because future generations are unlikely to derive any benefits from existing wastes, and have no voice in the selection of disposal sites, technology, and the setting of environmental radiological standards. Also, it is entirely possible that future generations will be more exacting on risk acceptability; in fact, recent experience in the U.S. with technological hazards suggests that this is likely. The recommended criteria should be for diminished risk to future generations.

Comments on Procedures

The EPA should be commended for its continuing efforts to open their decision-making process to the general public. We urge the EPA, and all other Federal agencies with responsibility for nuclear waste management, to continue to expand this program of sharing of general, and specific, policy issues with the public. Regulatory criteria for the different aspects of the waste management process need to be brought together in a common public process regardless of administrative responsibility. Thus there should be an integrating process that allows for collective discussion on criteria to protect workers, publics, and the environment for waste definition, processing, transport, and storage.

Notes

Brooks, Harvey, "The Public Concern in Radioactive Waste Management" (mimeographed, 1976).

Fischhoff, Baruch, et al., "How safe is Safe Enough? A Psychometric Study of Attitudes Toward Technological Risks and Benefits" (mimeographed, 1976).

Maynard, William S., et al., Public Values Associated with Nuclear Waste Disposal (Seattle: Battelle Memorial Institute, Human Affairs Research Center, 1976).

U.S. Environmental Protection Agency, Office of Radiation Programs, Considerations of Environmental Protection Criteria for Radioactive Waste (Washington, 1978).

STATEMENT OF CYNTHIA LEPHIEN

[Comment on proceeding on the assumption of infinite disposal space]:

Future radioactive wastes may be more hazardous as you approach the limits of space and absorbability of the biosphere. I would like to see the EPA (or whoever) do a study with an eye to possibly estimating the amount of space available for waste, whether we can overload the biosphere, and at what point the limits will be reached. The future nuclear wastes should be considered separately, at least to the extent that they may bring us to that limit.

STATEMENT OF NORMA B. LINSKY

I was unable to attend [the Forum]. I have, however, read the report [pp. 139-142, this volume] submitted in opposition to the continued manufacture of radioactive wastes. I wish to go on record in support of this report and add some comments of my own.

In the past eight years I have worked in research laboratories in the biological sciences; in physiology, biochemistry, and molecular biology. These laboratories were licensed to use radioactive isotopes.

Without exception in each laboratory I have seen criminal disregard for the potential danger of contamination. Most labs have too few containers for the disposal of glass vials and used pipets and test tubes. Those charged with the disposal are often uninformed as to what shield must be used with which isotope, and how to contend with spills.

In one lab, I witnessed a principal investigator dumping liquid waste down a drain and explaining that with enough water poured down with it, a sufficient dilution factor would eliminate any further contamination.

A postdoctoral fellow broke a bottle of liquid waste and, as it spread, exclaimed he was too busy to clean it up at the moment but would be back.

And what about the undergraduate who comes in to wash dishes and treats all those unlabelled vessels the same.

These horror stories were perpetrated and condoned by trained professionals. The thought of the continued production of radioactive wastes by an entire industry without adequate caution and knowledge of disposal is fearsome.

I only wish that you consider carefully before you condone potential abuse and harm.

STATEMENT OF CYNTHIA AND IRVING LORD*

We cannot attend the workshop in Denver, but wish to add our testimony. We have heard Dr. Teller assure us that we will develop the technology to contain or reuse nuclear wastes safely when that technology is needed. We have heard other renowned scientists state that this is far from the case.

It is our opinion that the burden of proof of safety lies with the industry. Steel containers rust. The near meltdown at Brown's Ferry demonstrates our fallibility.

Safe disposal of wastes is obviously going to be hideously expensive, if it is even possible, and we are not yet convinced it is possible. We recommend that security provisions at existing plants be made more stringent. We recommend no further permits for nuclear installations be granted until scientists are agreed that the plants are safe and that the waste materials are safely stored, and until economists can assure us that all this is worth the money it costs.

*710 North Mountain Avenue, Ashland, Oregon 97520

STATEMENT OF MR. & MRS. WILLIAM B. NEWBY*

It is urgent to have a MORATORIUM on Nuclear Energy.

It seems to me after exhaustive study that radioactive waste was not a problem till nuclear energy was developed at the close of World War II. First it was for military use only followed by great expectation that this form of energy was our great hope for an unlimited source of future energy. Now we are realizing that this form of energy is an uncontrollable monster that can destroy our civilization. Not only that but it now appears that instead of being a cheap source of energy it is turning out to be the most expensive form yet discovered.

THE COST is: TOO GREAT MONETARILY--and FAR too GREAT a threat to our health--in cancer, genetic defects, and long-term pollution of our air, water, and soil for present and future generations.

NUCLEAR ACCIDENTS. Who can afford a nuclear catastrophe? The utilities can't. Even the Federal government can't afford 14 billion accidents--the result of a reactor meltdown or severe earthquake where lethal gases have been released with resulting high loss of life and astronomical property damage.

RADIOACTIVE WASTE. There is no safe place in the U.S. for the expected 1 billion cu. ft. of lethal radioactive waste by the year 2000 (if present plans for reactors are implemented)--enough to cover a 4-lane highway coast to coast 1 foot deep.

Sweden has wisely called a moratorium on nuclear energy and France has cut back on their program.

Dr. John W. Goffman, M.D., Ph.D., professor of Medical Physics at the University of California, says, "What is really at issue is a moral question--the right of one generation of humans to take upon itself the arrogance of possibly compromising the earth as an habitable place for this and essentially all future generations."

THEREFORE--We should call a moratorium, civilian and military, in the U.S. before any more huge sums are expended on nuclear. Then begin the massive development of "SAFE" energy alternatives such as SOLAR, WIND, and THERMAL coupled with a well-rounded, comprehensive conservation program, with tax incentives for cooperation. I feel sure nuclear energy, the polluter, the killer, and uncontrollable would not be needed. And what an economic drain would be lifted and relief to be free of the dread of catastrophe.

* 604 Draper Valley Rd., Selma, Oregon 97538

STATEMENT OF ALEXIS PARKS*

Please include this letter as well as the enclosed letters from Drs. Bertell, Mancuso, Martell, and Najarian in the [proceedings].

I've enclosed a copy of the letter sent to Drs. Martell, Mancuso, et al. and have submitted their responses to the EPA with the understanding that permission for their publication has been granted.

In response to my request for a statement from Dr. Martell, I received, in the mail, a copy of his February 24th (1978) correspondence with EPA. For the sake of brevity, I have included only the introduction to Dr. Martell's discussion of alpha radiation and cancer. You have my permission to print the first page and a half of that correspondence and then refer interested readers directly to Dr. Martell for a complete copy of the 11-page correspondence.

I would like the enclosed letters entered into the record as a further indication of the inadequacies of current radiation standards as these standards address the issue of chronic public health effects from low levels of radiation, and as these standards rely for support upon the BEIR reports of the past.

While some established criteria and standards are better than none, I would recommend that the EPA lean heavily toward the conservative side in estimating permissible levels of radiation, perhaps even concluding that in the light of uncertainties in public health risks, a moratorium on the further generation of radioactive wastes will be necessary in order to enable the EPA to properly assess the seriousness [of the effects] of the low-level emissions upon public health. I understand the suggested "need" of commercial pressures to get the job done, but an established Congressional fund would do the same thing and thereby place nuclear power in its proper perspective: as an interim energy source.

In addition, I would recommend that it is essential that spent fuel rods and uranium mine and mill tailings be included as radioactive wastes and subject to strictest control by EPA.

* P.O. Box 1917, Boulder, Colorado 80306

March 6, 1978

Dear Ed,

Members of the Colorado Friends of the Earth, Boulder Mobilization for Survival, (former) Coloradoans for Safe Power, Rocky Flats Action and others* have been encouraging active citizen involvement in the upcoming Environmental Protection Agency's (EPA) public workshop on "Environmental Protection Criteria for Radioactive Wastes." The workshop will be held in Denver, March 30, 31, and April 1st.

We are concerned about the term "acceptable risks from radioactive wastes" because we feel that insufficient government attention has been focused upon scientific research which deals with potential and/or actual public health effects from low levels of radiation.

Because of your research efforts in this area, we would like to request a written statement from you illuminating—within a paragraph or two—your primary concerns about the public health risks/effects from low level radiation.

Although we have papers relating to the general nature of your work, we feel that such a statement can be effective in two ways:

- . We would like to quote from it to support our lay fears about possible risks from low levels of radiation.
- . We will ask that it be entered into the formal records of the national workshop.

Because the EPA workshop is scheduled to begin a few weeks from the date of this request, will you please send your letter to Ms. Alexis Parks, PO Box 1917, Boulder, Colorado 80306, by March 27. Thanks.

Alexis
(for *)

cc: Drs. Martell, Mancuso, Morgan, Najarian, Puck, Sternglass;
and others.

ROSWELL PARK MEMORIAL INSTITUTE



Robert P. Whalen, M.D.
Commissioner of Health

Department of Health • State of New York

666 Elm Street • Buffalo, New York, 14263



Gerald P. Murphy, M.D., D.Sc.
Institute Director

March 28, 1978

Environmental Action Reprint Service
2239 East Colfax
Denver, Colorado 80206

Dear Ben Billings,

My concerns relative to the Radwaste Criteria have to do with the exposures of workers and of the general public to radiation. The low-level radiation effects have been seriously underestimated, and the present federal guidelines for exposure are seriously out of line with current research findings.

I would recommend that workers be allowed to accumulate no more than 0.1 rad whole body exposure per year after age 25 and before age 45. All other members of the general public should be protected as far as possible from all unnecessary radiation, and there should be no planned-in exposure in excess of 0.01 rad. Since a chest x-ray gives a bone marrow dose of 0.001 to 0.010 rad, and since a chest x-ray is a serious hazard to health only to be risked when there is an over-riding benefit to the person receiving it, even this permissible level is a risk. I suggest it only in an effort to safely dispose of the nuclear waste which is already generated by this life-threatening technology. I do not condone further pollution of the environment. I would further caution you against meaningless average estimates of radiation exposure. Upper limits to persons are needed.

Sincerely,

Rosalie Bertell, Ph.D., GNSH

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University of Pittsburgh

GRADUATE SCHOOL OF PUBLIC HEALTH
Department of Industrial Environmental Health Sciences

March 16, 1978

Ms. Alexis Parks
P. O. Box 1917
Boulder, CO 80306

Dear Ms. Parks:

This is in reference to your letter. I have just returned from an extensive trip.

Our conclusions basically are that the so-called "safe" radiation standards which have been used as a guide to protect the industrial workers, are not safe at all; that workers who have been exposed to radiation greatly below that level have developed an increased risk for certain types of cancer. The radiation induced cancers identified were bone marrow cancers (multiple myeloma and myelogenous leukemia), cancer of the pancreas and cancer of the lung.

The estimated doubling dose, the amount of radiation to double the so-called "normal" risk for developing cancer among workers was for bone marrow cancer, 3.6 rads; lung cancer 13.7 rads; cancer of the pancreas, 15.6 rads; all cancers, 33.7 rads.

Since we estimate that the risk is 10 times greater than was recognized before then the radiation standard should be reduced 10 times.

Secondly, the estimate permissible level for populations around nuclear facilities, which is a fraction of the standard for workers, would have to be reduced 10 fold.

Sincerely,


Thomas F. Mancuso, M.D.
Research Professor

TFM:alb
Enclosure

24 February 1978

TO: Director, Criteria and Standards Division, Office of Radiation Programs, U. S. Environmental Protection Agency, Washington, D. C.

FROM: Dr. Edward A. Martell, National Center for Atmospheric Research,* Boulder, Colorado

SUBJECT: Comments on "Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the Environment," Report of the U. S. Environmental Protection Agency, September 1977.

1. Introduction

In response to Federal Register Notice FRL 808-5 issued 30 November 1977, I submit comments, below, on the proposed guidance. The question of acceptable levels of public exposure to alpha radiation emitting contaminants is of sufficient consequence to demand the attention of able, objective scientists who are sensitive to the limitations of our understanding of the chronic health effects of alpha emitters. < Alpha emitters are extremely effective mutagens and well established agents of cancer in man. Any serious consideration of the unresolved questions regarding the contributions of alpha emitters to the general incidence of genetic effects and cancer in man would raise more questions than answers. > Assessment of the microdistribution of internal alpha emitters and their role in spontaneous mutation, aging and malignancy is, in my view, the most serious, neglected area of radiation health research. In this context, the proposed guidance is hopelessly unacceptable. Its estimates of health risks are based on the models and recommendations of the National Academy of Sciences BEIR Committee reports of 1972 and 1976 which have very serious shortcomings with regard to the internal organ distribution of natural and pollutant alpha emitters and their effects (see below). The guidance is based on an assumed linear relationship between alpha radiation dose and cancer risk, an assumption which may be completely inapplicable and which can result in a substantial underestimation of the cancer risks (see below). Authors of the guidance admit that the uncertainty in estimating genetic risks is even larger than that for cancer risks. In the face of such unknowns and uncertainties, it is most remarkable that the unidentified authors of the guidance could find it possible to propose that it is accept-

*The National Center for Atmospheric Research is sponsored by the National Science Foundation

able to expose the public to plutonium contamination in surface soils at a level of 0.2 μ Ci/m₂ in the top 1 cm layer--about 200 times the level of fallout plutonium in surface soils of eastern Colorado.

On the basis of considerations discussed below, insoluble alpha emitting particles which accumulate at tumor sites and germ cell sites should be singled out for particular attention as possible agents of the rising incidence of cancer and genetic effects in man. These are very serious possibilities that can be tested experimentally. Picocurie quantities of alpha emitters may very well explain the high incidence of bronchial cancer in smokers (see below). Organ burdens of fallout plutonium in the general public have already reached levels of ~ 0.5 pCi/kg in lung tissue, ~ 0.7 pCi/kg in the liver, and comparable levels in the gonads and other organs (Moss and Campbell, 1972). Depending on the microdistribution of this alpha activity in the gonads and at tumor sites and on the mechanism of cancer induction, this fallout level of alpha activity may be contributing substantially to the rising general incidence of cancer and genetic effects in man. If so, exposure of large sectors of the general public to 200 times higher levels would have tragic consequences. What is now urgently needed is intensified research on the microdistribution of alpha emitters in man and an objective assessment of the chronic health implications of such distributions. Based on present knowledge, the only responsible recommendation regarding public exposure to insoluble alpha emitting particles would be that such exposures be restricted to the practical minimum. That practical minimum is, unfortunately, the level of fallout plutonium in surface soils. ←

Copy of handwritten letter:

March 11, 1978

Dear Ms Parks,

All I have to say at this time is that the complete study on former nuclear shipyard workers will be completed in perhaps 2-3 years. I'll be working with the CDC on this project. My preliminary study, which is being prepared for publication at this time, seems to indicate a greater health risk than previously thought. My own theory is that exposure to radioactive materials as opposed to X-rays or radiation from an external source, may cause more tissue damage from within than would be indicated by measurements from a radiation badge.

→ At any rate, it is clear to me that up to now there are very few studies on the occupational exposure to "safe" levels of radiation and radioactive materials. The newer studies (mine, Mancuso, "Smokey" done by the CDC) seem to indicate an increased risk for cancer and leukemia for low levels of radiation. Previous studies (mostly A-bomb survivors in Japan and people exposed to medical X-rays) do not come close to predicting the amount of disease from a given radiation exposure, when one is exposed to radioactive dust, materials, etc., and the exposure is measured in REMS by a radiation badge.

Yours sincerely,

Thomas Najarian, M.D.

STATEMENT OF C. B. PEARSON*

[Comment on Opinion 3b on p. 40 of Summary and Conclusions of Working Group II]

The risks involved with the proposition of burial are not adequately known. Therefore, basing your analysis of risks on comparison of exposed versus [buried material] is making an inadequate statement of comparison; i.e. [there is] no data base for [the] assumption.

*CoPIRG/UNC

STATEMENT OF THE COMMONWEALTH OF PENNSYLVANIA*

The Commonwealth of Pennsylvania appreciates this opportunity to comment on EPA's Background Report on Considerations of Environmental Protection Criteria for Radioactive Waste, February 1976. In general, we feel that the report is very vague and philosophical in nature and as such may not fully address the many technical and social parameters that require investigation before generally applicable environmental protection criteria can be formulated.

We are very concerned about the pace of the EPA program for development of criteria for radioactive waste disposal. In particular, we are concerned that the low-level program is not as aggressive as the current situation dictates. As you are no doubt aware, recent occurrences in the commercial low-level waste disposal field have essentially eliminated the availability of burial space in the eastern part of the United States for future additional sources of this waste. Not only does the pace of the EPA program fail to recognize this critical situation, but it also appears to be lagging the NRC program for development of criteria and standards. This situation appears unsatisfactory since it is apparent that EPA's generally applicable criteria should be in place prior to the finalization of NRC's licensing criteria and standards, so that the two are compatible. The failure to respond in an aggressive manner in this area could be more crucial in the short term to the many widely varied users of radioactive material, in that lack of authorized burial space could cause an immediate shutdown of essential services in these areas.

It is perceived by many technical people in the waste disposal field that the environmentally acceptable disposal of hazardous waste is more of a problem than the disposal of radioactive waste. This is due in part to the enormous quantities that are generated by various industries and their current methods of storage. In addition, their persistence as a hazard and the limited knowledge of their health effects make them in some cases as hazardous as transuranic radioactive waste. It is therefore recommended that any environmental protection criteria developed for radioactive waste be applicable to all hazardous wastes so that the public can be assured that equal hazards are being treated equally.

Our specific comments on the Background Report are as follows:

1. The report discusses the philosophical concepts of zero release and zero risk. In this context it should be recognized that zero risk cannot be guaranteed for any technological undertaking, nor can zero releases be guaranteed for any waste disposal operation. It is therefore recommended any reference to these concepts be deleted in the criteria document in favor of more reasonable goals which are achievable.
2. It is suggested in the report that risk estimates should be performed for at least 1,000 years, regardless of the type of waste. While reasonable for high level and TRU wastes, it may be inconsistent with other considerations (pp. 38 and 43) for typical low-level waste. The longest-lived significant contributor to LLW have at most a 30-year half-life. After 1,000 years, based on the typical initial specific activities of this waste, the specific activity would be several orders of magnitude lower than

*Received from Thomas M. Garusky, Director, Bureau of Radiological Health, Dept. of Environmental Resources, P.O. Box 2063, Harrisburg, Pennsylvania 17120.

the average natural activity of the soil. This would therefore suggest that the duration of risk be based on the persistence of the type of waste considered. The longer-lived contributors inherent in LLW could be controlled by placing a maximum allowable limit on these particular long-lived isotopes. This limit should be based on a pathway analysis for each specific long-lived isotope.

3. Ra-226 sources are mentioned in the report as an example of fabricated naturally radioactive wastes. It is understood that this radioactive material will be included as a hazardous waste in future EPA regulations. Since this isotope has one of the lowest MPC's in water, it is equivalent in hazard to TRU waste. Therefore, its treatment in a less restrictive manner as a hazardous waste is not consistent and further supports the above recommendation that any environmental protection criteria developed for radioactive waste be applicable for all hazardous waste.
4. One of the few items in the report which can be called criteria appears as item 5 on page 53. While these features may in some cases be desirable, they are not necessary to assure adequate containment over the hazardous lifetime of low-level wastes. In fact, sedimentation could lead to a surface water infiltration problem, instead of providing additional containment.
5. The report states that engineered barriers generally can be considered only as interim measures for containment. Including this concept in the criteria may be too restrictive, especially for low-level wastes. State of the art advances may be such that engineered structures could prove to be the primary barrier to release.

We would hope that these comments receive your utmost consideration.

STATEMENT OF MICHAEL H. RAUDENBUSH*

I participated in the recent EPA public meeting on radioactive waste criteria held in Denver, and I wish to submit for the record the following comments. These are my personal views.

BACKGROUND

I attended most of the meetings of Working Group I ("What is Radioactive Waste?"), and am only familiar with the proceedings of the other two groups insofar as they were presented at the final plenary session.

COMMENTS PERTINENT TO GENERAL MEETING

1. I believe that public meetings such as this can be productive in dealing with genuine public concerns. However, they can also be abused by special interest groups, both pro and con. Applying this general observation to the specifics of the meeting, it was my observation that Working Groups I and III were considerably more successful than Working Group II at allowing the various points of view to come together to a consensus. Whether this was due to the group size, the time allotted, or the quality of the moderator is not clear. What was clear was that the final report for Group II consisted almost exclusively of positive and negative statements juxtaposed, with no real resolution of issues. I would therefore suggest that in the future such meetings be very carefully structured to allow for smaller working groups with highly qualified moderators. The maximum size of a working group should be 20, the time allotted for discussion should be ample so that no one feels he must present speeches, and the moderator must occupy a middle ground in viewpoint and be reasonable and articulate. Mr. Al Hazle, who moderated Group I, is a splendid example of a highly qualified moderator.

It is clear that some of the participants (a minority) were present not to solve problems but to use the exposure to promote various special goals which were not necessarily related to the purpose of the meeting. The participation of these individuals, although unavoidable, was nonproductive. Specifically directing my attention to the final meeting report, I would point to various gratuitous comments inserted by these individuals. As a case in point, I refer to the Group II report, page [39, last sentence]. Such remarks should certainly be stricken from any records other than verbatim.

2. A particularly obnoxious idea threaded its way through much of this meeting and this idea was promulgated by the antigrowth, antitechnology special interests. This idea was that no risk from radioactive waste is acceptable. I believe that when pressed on this issue, this position really may be read to be "no risk from nuclear power is acceptable," as the proponents are quick to add that risks from use of radioisotopes for medical purposes, for example, are acceptable.

* 765 Lafayette St., Denver, Colorado 80218

The "no risk from radioactive wastes is acceptable" viewpoint may, in my opinion, be interpreted in one of two ways: either a fundamental lack of understanding of the nature of technology, or the pursuit of an ulterior goal: to wit, the promulgation of criteria which are impossible to meet by nuclear technology, and therefore a moratorium on nuclear technology. Such a viewpoint should, in the name of reason, be vigorously assailed.

3. The goal of radioactive waste management should be to maximize societal benefits relative to potential damage. This goal must be applied across the board to include alternative technologies to those which produce radioactive wastes. I believe that this fundamental goal was not adequately addressed in the meeting and I would like to insert this position for the record. Although it may be argued that the maximization of benefit/damage ratios is outside the scope of EPA'S responsibilities, I would argue that this is not the case. The reason for this is that EPA'S responsibility is to protect the general public from the entire spectrum of potential environmental risks. It is impossible to do this without understanding the tradeoffs between alternative courses of action. This observation applies to all radioactive wastes, whether produced in the field of medicine, nuclear power generation, or weapons. In each case, there is a benefit to be derived, although not necessarily quantifiable. Although the quantification of these benefits may be subjective, it is essential that this exercise be performed, or the designation of acceptable risks from radioactive waste management becomes a criterion adrift without an objective anchor.
4. It is my personal opinion that it is necessary to include in the criteria for radioactive waste management some sort of discounting of risks into the future. Especially after long periods of time (perhaps after several hundred years), perceived risks from a single health effect must be discounted by some percentage. This is necessary, in my opinion, in order to account for the uncertainty of technology which may be available in the future for dealing with cancers, or removal of hazardous isotopes from the environment, or simply uncertainties in the future of the human race.
5. The idea that it is necessary to have an absolutely proven method of radioactive waste disposal before the generation of additional wastes may be allowed is of questionable merit, in view of the large quantities of wastes existing now and being generated every day. To arbitrarily cut off the generation of such wastes, pending a "solution" to radioactive waste management, would be arbitrary and capricious. It appears to me that the proponents of this philosophy are simply utilizing this suggestion as a backdoor entrance to promote a nuclear moratorium. The proponents of this point of view generally wish it to be applied only to nuclear power generation and weapons production, not to "beneficial" (in their eyes) uses such as medical research or medical therapy. The existence of radioactive waste is de facto. It is the management of this waste which must be addressed, and it is not productive to simply demand an end to the generation of such waste.

REMARKS SPECIFIC TO WORKING GROUP I

Regarding items F and K of the Working Group I final report, I would like to express the opinion that any criteria generated must clearly state that an individual or an industry is not required to reduce radioactive effluents below the existing background at the specific site in question. For example, it is nonsensical to require that water returned to a stream be cleaner than when it was removed, be it regarding radioactivity or any other pollutant. I believe this point was obscured in the report as presented.

Regarding Item N of the Group I report, I believe that multiple categories of radioactive waste must be addressed and differentiated, based upon hazard to humans. For example, I believe it is important to differentiate between high-level fission products, transuranic contaminated low-level wastes, non-TRU low-level wastes, etc. The reason for making this categorization is that the handling procedures and degree of isolation should clearly be different between these various waste categories.

[In Item V] of the Group I report the last sentence reads "It was suggested by some that there should be broad public participation and funding to present views of environmentalists." It is my opinion that environmentalists represent a special interest group and therefore this sentence should be changed to read "the public" instead of "environmentalists."

[In Item X], Group I discusses suggestions for public participation in the future. I take issue with one specific suggestion, and that is that proceedings of such meetings be "dumbed down" to satisfy the nontechnical public. I object to the "dumbing down" of any issue, technological or otherwise. Attempting to reduce discussions of technologies or public policy to the lowest common denominator are counterproductive. It is necessary to speak in precise technical language when discussing precise technical subjects.

Another comment I have regarding public meetings is that, while I generally agree with the value of such meetings if they serve the purpose of responding to genuine broadly perceived public concerns, I believe that increasingly in the future we will see this type of meeting abused by special interest groups to slow down the development of various projects to which they are opposed. I would simply caution that EPA use sound judgment in determining whether the true interest in a particular issue is a broad public interest or is simply the interest of a narrowly focused group in delaying a particular rule-making or technological advance.

I very much appreciate the opportunity to include these remarks as background information for the Denver meeting.

STATEMENT OF SAM SCHERF*

While your public forum deals with the environmental criteria for radioactive wastes, my main purpose in writing is to inform you that most any decision that would aid the United States in national policy regarding energy should be one of the main criteria. Without this issue being settled, it appears that immediate needs of energy cannot be taken care of as evidenced by the recent imbalance of energy production sources which caused many people in the mid-central and eastern United States to lose their job employment, productivity, etc. during the recent coal strike. You are discussing a problem that for the short term needs immediate action. If later you find that you have not made the best alternative, then change the location of storing of this waste at that time.

In addition to urging you to take as expedient action in developing your solution as possible, as a laymen I would offer a solution of storage within underground areas that would be safe from ground water flows. I'm sure the containers you would choose would be safe, but I personally would like this extra protection, knowing that if there was any leakage, it would not be distributed by the way of any fluid flows such as water, air, etc.

*Executive Vice President, Chamber of Commerce, 124 West 4th Street (P.O. Box 367), Cedar Falls, Iowa 50613.

STATEMENT OF ANNA E. WASSERBACH*

Would very much have liked to attend the Denver forum. However, since I cannot, I would like to endorse some of the proposals presented at the Reston, Virginia, and Albuquerque, New Mexico, 1977, workshops.

I am pleased to see, in Background Report, Considerations of Environmental Protection Criteria for Radioactive Waste, Feb. 1978, for what is to me the first time, the ethics of leaving radioactive wastes to future generations being considered along with the technicalities of disposal and/or containment. We would certainly not find ourselves with such a degenerating environment if morality had always been a consideration in man's actions. Unfortunately, reality, or perceived reality, and technicalities have been the driving forces on whether a certain activity should or should not be engaged in. Those who would add the third dimension of morality were called "cry babies" as with Dr. R. Oppenheimer, or some other derogatory characterization.

I also endorse the concept that waste disposal be considered in terms of 1,000 years, rather than the "interim" storage now used of life-of-plant. I do not endorse the Dept. of Energy's proposal to accept radioactive wastes from utilities on a one-time-fee basis. The cost of disposing of wastes, whatever the manner deemed feasible, should be the responsibility of those creating the wastes. The same holds true for medical and industrial radioactive wastes, and particularly so since it is expected that the amounts of wastes from such sources (in addition to agricultural uses) will increase. If the people generating the wastes have to pay to clean up what they do, they may be a little more conservative in finding new "commercial" uses simply because it is profitable, but, again, without really knowing the long-term consequences of such uses. This March 1978 forum would not be taking place if those promoting nuclear power had had to face the waste disposal problem as they created it.

I have repeatedly seen the term "remedial action" to be taken when wastes migrate from a site into surrounding water, air, and soil. When I asked specifically in relation to West Valley, N.Y., what this "remedial action" is, I was told it was yet to be determined. I hope that "remedial action" is not just a catch phrase awaiting another technological solution.

I also endorse the proposal that radioactive wastes should be provided greater security against major adverse consequences of failure than is acceptable for dams, dikes, etc. (pp. 41-42 of Background Report). While any of these "commonly accepted risks" (as the nuclear industry is so fond of referring to) can cause great human and environmental devastation, man has not ever, in recorded history, experienced any dangers of such long range as those posed by nuclear wastes.

In the preface, Dr. James E. Martin states that EPA's charge as of 1970 was to "advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for Federal agencies in the formulation of radiation standards... ." It must be very difficult for EPA to fully carry out this mandate if it does not know what is now in the environment. The NRC appears to be in a mad scramble to grant

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special licenses for nuclear materials. One way for them to solve their waste problem is by finding "commercial" applications, again, without long-term consequences. While each research, medical, commercial, etc. application may be considered small in itself, NOWHERE have I seen [considered] the cumulative effects on human health of the total use of radioactive materials. Each nuclear generating station is given its "permissible dose" of release into the air and water, but, again, not cumulative amounts for what is or will be in the environment. I would like to suggest the ultimate "interim" solution, and that is ceasing the generation of any more radioactive wastes (with the exception of medical applications) and including research applications, until we really know what to do with what is already here. Certainly those now employed in radioactive waste management jobs will have enough to do for the next 1,000 years. However, as critical as I may sound, I am completely opposed to the Dept. of Energy taking charge of all environmental monitoring to do with energy generation. That would be the final assault on humanity. If there is any support I can lend to EPA to ensure that they retain monitoring of the environment, please let me know.

STATEMENT OF JUDITH K. WILKINSON*

I participated in [the Forum] and below are some corrections I have for our working group's report.

I was in Working Group I: What is radioactive waste?

1. The report does not adequately reflect that a substantial number of us in the working group were addressing atomic weapons as well as atomic power. [Item V] should read, "Should there be a moratorium on nuclear weapons and nuclear power in the U. S. until a satisfactory waste disposal technology has been approved?" Our group said an overwhelming YES. In addition, whenever radioactive waste is referred to, waste from nuclear weapons is included.
2. See [Item] M. Should there be distinctions between high- and low-level wastes in the criterion defining radioactive waste? The consensus of the group was not as it is reported. Our group (approximately 1/3 to 1/2 of the working group) intended that distinctions should not be made between low-level and high-level wastes, either in the definition of radioactive wastes or in the criteria addressing the control measures or in the standards promulgated by the regulatory agencies. The reason for this is that there is research which indicates that low-level radiation is much more dangerous than was previously thought (see research done by Edward Martell of the National Center for Atmospheric Research, Boulder, Colorado and reports from Karl Z. Morgan at the Georgia Institute of Technology).

I appreciated the steps taken by the Environmental Protection Agency to involve the public in these decisions. I found the conference very helpful as a way of putting industry and environmentalists in better communication with each other as individuals.

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STATEMENT OF DAVID YOUNG* †

Since my personal participation in the Forum consisted mostly in attendance at and input to the workshop session of Working Group II, I will confine my comments mainly to the written report of that group to the EPA.

I felt privileged to sit at this particular workshop, since the questions of the reliability of current methods of risk assessment, and of what level of risk is to be acceptable to society, and of how it is to be determined that society as a whole does, indeed, accept those risk, are, I feel, central to a wise structuring of standards for the nuclear industry by the EPA.

I would like to state at the outset that, although I did not agree completely with the method of selection of our group's drafting committee, I feel that their written report gives an accurate reflection of the views expressed during the workshop session.

I feel called upon to make these comments both to emphasize my agreement with some of the viewpoints expressed by members of the group and to point out some assumptions which were made by others in expressing their viewpoints--assumptions which I find both unfounded and also frequently quite disturbing in that they might be uncritically accepted by the EPA or others reading the Forum's written report.

My comments on statements made by members of the group will fall basically in the order that the main issues came up during the general workshop discussion, with comments on each issue being grouped together (as each issue was generally discussed through the course of several agenda items in the actual workshop meeting).

First of all, I can say that I thoroughly agree with the statement formulated by the EPA in Item 1 of the agenda, and concur with the group consensus .

As for Item 2, I feel that the choice of 1,000 years as the responsible limit for estimating the potential health effects of wastes is completely arbitrary and unrealistic, inasmuch as the wastes remain volatile for hundreds of thousands of years, and must therefore be guaranteed not to exceed acceptable risk standards for every bit of that time. If uncertainty factors in risk assessment become extreme after 1,000 years, we must consider that we are exposing generations following that time to an unknown level of risk; a situation which we would surely never want to place our own generation in (although it seems to me that we are willing to do even this, as I will attempt to make clear later).

One of the most fearful uncertainty factors, to my mind, is the likelihood of future geological upheaval or other basic changes on the face of the earth (Ice Age, etc.); changes which increase in likelihood of occurrence as we get into the thousands and tens of thousands of years, and any one of which could cause a major release of stored radioactive waste materials into the biosphere.

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† The following people, all attendees at the Forum, wish to signify their agreement with the views expressed in this manuscript: Carolyn Landes; Eugene Hanus, Jr.; David Landes.

This question of the degree of uncertainty in risk assessment was a bone of much contention throughout most of the workshop discussion. The setting of standards which are designed to effectively hold the health risks within certain given limits presuppose the existence of fairly accurate methods of determining just what those risks are. It was assumed (and stated) by a number of people at the workshop that such methods are available, but for a number of reasons I believe that this assumption is based on misinformation, wishful thinking, and disregard of the past record of the nuclear industry. Misinformation lies mainly in ignorance of the latest findings of researchers into the biological effects of low-level radiation. One important study in this field is currently being done by Dr. Edward Martell, a nuclear chemist at the National Center for Atmospheric Research, in Boulder, Colorado. The findings of Dr. Martell and his colleagues are already indicating that the power of low-level alpha radiation to effect genetic changes in living cells (the cause of cancer) may have been previously underestimated by a factor of up to 10,000/1 (ten thousand to one).^{*} It was a consensus of our group that "any standard selected would be subject to future change as future data become available." I would like to suggest, however, that no accurate standards can be set which are based upon data from a field with such a rapidly shifting data base, and that it might prove suicidal to err in any direction but the most conservative one when risking exposure to such lethal substances over periods of many millenia.

Statistical verification in the human population of findings of Dr. Martell's researches and any others currently going on may start coming in soon in the form of a rise in the cancer rate across the general population, and specifically in those areas in close proximity to nuclear facilities. Some of the cancers which can be induced by radiation have latency periods of 20 to 40 years. The nuclear power industry is still less than 25 years old.

Human error was mentioned several times in the discussions as a major factor contributing to the ultimate uncertainty of any risk assessment. This factor, which manifests itself both in poor and unsafe design of facilities and in accidental wrong procedures executed within those facilities (whether well-designed or not) is, I believe, perhaps the largest and most immediately dangerous uncertainty factor to be dealt with. Without going into the hundreds of accidents that have occurred over the past 25 years at both military and commercial nuclear plants, I will state my belief that an examination of the past record of the industry would be enough to make anyone doubt the present capability of that industry to guarantee to keep the level of its emissions of radioactive material to any given standard--even today's liberal standards (much less the much more conservative ones which I believe are needed).

I feel it is an extreme and dangerous form of wishfull thinking to believe that the industry's performance will, for some reason, suddenly make a dramatic improvement--as long as designers and technicians remain less than perfect (as they always will).

It should be fairly clear, to anyone who takes more than a casual look at the evidence, that this radioactive material which we continue to produce in great quantities is something which we still know little about: neither of its real long-range effects on the human organism, nor of how to effectively contain it within the limits of even our guess-work standards.

^{*}Alpha radiation is the most effective known agent for the production of malignant chromosome damage.

I have much more to comment on concerning the topics discussed by our group, but since I have limited time left to conclude these comments, I will mention only one more issue which I feel needs to be considered thoughtfully by the EPA in setting standards for the nuclear industry. This is the question of the extent of public input which is desirable in helping the EPA with the decision-making process. The way I see it, the EPA is an agency whose purpose for creation is to serve as an agent of the people in executing their will on matters of protection of the environment. This is explicit in the nature of the democratic system within which it operates. For this reason, I feel that public input on this matter should be as broad-based and as well informed as possible. For this reason also, I find one statement made by the representatives of the EPA attending our workshop to be especially disturbing. That is the statement that, "no single commonly used method of determining risk acceptability (i.e., solely by cost-benefit analysis, or by comparison with other technologies, or by means of polling public opinion) was by itself adequate for dealing with the problem of nuclear waste management, and that, therefore, a complex set of assessments involving all these factors needed to be undertaken."

I feel quite strongly that, rather than considering all of these factors equally or in some form of conceptual balance, the determining factors in decision-making should be accurate assessment of the people's will on the matter (by voting or any other accurate means), and that the people should be educated so that they can make the choice with consideration to the other factors mentioned, rather than having their will balanced against these abstract factors. I feel that the broadest possible public input is needed for making these particular decisions, considering the cataclysmic magnitude and irreversible nature of the possible consequences of the wrong decisions. I do not wish to place the burden of these decisions on any group of people as small as the EPA, and I fear that their decisions may be influenced by such unfair but undeniably effective pressures as concentrated propagandizing by the nuclear industry and pressures from other governmental agencies and departments.

And now my time really has run out. I would like to thank you for your consideration of the views expressed in these comments.

STATEMENT OF PAUL C. ZUCKER*

There is substantial agreement that a long-term geological waste disposal site must be designated to handle the ever-increasing amount of radioactive waste being generated. In California, the Public Resources Code Section 25524.2 prohibits the certification of any new nuclear power plants until it can be determined that a demonstrated technology or means for permanent, terminal disposal of high-level nuclear waste exists and has been approved by the appropriate federal agency. The California Energy Commission has concluded that it is impossible to make an affirmative determination at this time. Until the Nuclear Regulatory Commission (NRC) does bring a repository on-line, it would seem imprudent to continue deployment of light water reactors throughout the United States.

When a site has been chosen for waste disposal, the impacted jurisdictions should be solicited for their opinions as to the feasibility and desirability of the site. By allowing for local input, the public could be informed as to the risks inherent in the burial of wastes in their area.

There has been great concern among segments of the public about radiation leakage in the area of high-level waste sites. To defuse this concern, a baseline public health survey could be undertaken before any wastes are implaced and then dicennial surveys undertaken thereafter to enable public health officials to monitor any effects the site implacement has on employees of the plant, inhabitants of the area, and their offspring. This data will enable scientists to be better able to gauge whether current safeguards are adequate.

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STATEMENT DISTRIBUTED AS A FOURTH REPORT*

The following statement is submitted for the record on behalf of some individuals and representatives of public interest nuclear opponent groups attending this EPA conference on environmental protection criteria for radioactive wastes.

We commend EPA's undertaking to formulate sorely needed criteria as a necessary first step toward a more rational approach to radioactive waste control. We recognize the difficulty inherent in this endeavor to solve a problem many of us regard as unsolvable. Many of us offer the agency our continuing assistance in these efforts and pledge our help in making the American people aware of the unparalleled gravity of this national and worldwide problem.

We urge EPA to consider carefully and to act upon our criticisms and recommendations.

First, we believe, in the absence of fully proven disposal technology, that there is no moral justification for the commercial or military production of any additional quantities of radioactive waste, except those generated by clean-up activities.

We ask EPA to join us in recommending to Congress and the President that a moratorium be imposed on the further creation of radioactive wastes so that the pressure from such a continued buildup of radioactive wastes will not force a hasty, less than acceptable waste disposal solution.

Recognizing full well the possible short-term societal disruptions that could attend this proposal, we anticipate submitting a subsequent discussion paper to EPA. We suggest, however, that a 10% reduction in national electricity supply could provide a splendid incentive for immediate implementation of conservation and alternative energy sources.

Secondly, although we appreciate the urgency of moving forward toward waste disposal solutions, we sense and strongly protest the blind formulation of governmental policy in the absence of sufficient data [and] knowledge and adequate participation by the American people.

We offer the following criticisms of and objections to the purpose, structure, and processes of this conference and to some of the philosophical and substantive issues discussed, and not discussed, in the workshops:

Many of us are not so deeply immersed in nuclear power technology as EPA personnel and are approaching these issues freshly, with a "layperson's" perspective. Thus, in addition to the technical comments above, we feel that there are a number of ways in which future public forums on this subject can be improved in procedure.

The American public should be more widely informed about the event, its contents, and the ways in which response to the conference agenda can be carried out. More advance notice about the forum should be given in the general public media, including nationwide newspaper and television coverage. Future forums should be scheduled for evenings or weekends to permit participation by working people.

*Received 10 April 1978 from J. Hurley.

The expectations of work to be done by participants should be defined in more detail in advance. Defining these in advance would reduce the rush of formulating criteria in a mere two days at the public forum.

One criticism, widely accepted, is that the background report is obscure and insufficient to the need; it should include much more about the procedures and conclusions of the previous workshops.

The proceedings of the forum should be recorded verbatim. The lack of a verbatim record has raised doubts about concern by EPA for public comment.

Further, many of us noted with distress that, among the EPA staff, women appeared to be present only as receptionists, and that they appeared to be totally excluded from the serious thinking within the Agency about the waste disposal problem. This fact is perceived as being related to the extremely abstract, rationalistic, and emotionless language in which the issues were presented to the public. We object to the divorce of feeling from these considerations as having a numbing effect on our ability to appreciate the real life and death implications of what is being decided.

We feel that several important technical questions were not discussed or were not given appropriate weight in discussions which did occur, which nevertheless may have important implications for the criteria. Among these are:

1. The role of alpha emitters as mutagens in nature. It is known that alpha particles exhibit powerful mutagenic effects under laboratory conditions and that such effects can, in principle, lead to genetic abnormalities and malignancies. If, contrary to current popular theory, alpha emitters play an important role in the natural mutation process, such effects may have profound implications for the criteria relating to the handling of actinide wastes and permissible actinide leakage from nuclear processing facilities.
2. Hundreds of thousands of Americans were exposed to various amounts of radiation as a result of their participation in the atmospheric testing of nuclear weapons. The epidemiological studies of these people are only now beginning and their findings surely will have important implications for our criteria. Despite the risks of hasty evaluation, results of preliminary studies should be made available within six months and evaluated by the EPA without delay. Other epidemiological studies now in the literature have been given little weight owing to the incongruence of their results with the wishes of the nuclear community. These studies must be evaluated by competent and unbiased personnel and the result of those evaluations must be given due consideration by the EPA.
3. Lithospheric disposal of radwastes is only one of several potentially viable options. Clearly, such alternatives as space disposal and proton accelerator transmutation have associated criteria which merit identification. This should be accomplished through further public-professional agency discussion, as should evaluation of alternative forms of geologic disposal.
4. Return of high-level radwastes from overseas has been accepted by the U.S. as an option to be available to foreign purchasers of U.S. built and fueled reactors. What are the criteria applicable to such shipments? What criteria, if any, among those applicable in this country are appropriate to evaluations of foreign operations?

5. As stated in point 1 above, alpha emitters are known, powerful mutagens. Their impact upon other organisms in the biosphere has clear implications for rational control criteria, yet this issue has received little attention to date.

As the public, while we accept full responsibility for the comments offered by the public-interest groups represented here, and while we recognize EPA's need to proceed with the drafting of appropriate environmental protection criteria for radioactive waste, we feel that the EPA has not sufficiently discharged its responsibility to solicit informed public input to these criteria.

In particular, we feel that a substantial effort must be made by the EPA to solicit, consider, and respond to the views of that portion of the scientific and professional community holding views at variance with the currently popular theories. Further, the gravity of the issues addressed by these criteria demands the fullest practicable participation by the general public. This implies an extensive effort on the part of the EPA to establish and maintain communication at the grass-roots level, the effect of which will be to ensure a complete presentation of all substantive questions.

In the philosophical realm, we found the proceeding gave inadequate attention to the issue of equity in the distribution of the burden of risk in time and space. We suggest EPA give substantially greater consideration to the concept of distribution justice.

In the very formulation of the issues and the conduct of the conference, hubris, a lack of humility in approaching this awesome task, permeated the forum.

A number of us felt that the forum seemed to be based on a view of humans as purely rationalistic and unemotional beings, and that the issues and arguments sprang from assumptions such as these. The conference appeared to some to be designed to discourage and prevent the exploration of human values underlying the decisions on nuclear waste creation and disposal. The expression of sensitivity to the well-being of people in the future and sympathy for those suffering the painful and horrifying results of present radiation exposure was also excluded.

It is dismaying and symptomatic of the destructive [character] of contemporary nuclear technology that many features of this conference indicated a refusal to consider people as much more than statistics. Worse still, it frequently seemed people just amounted to a certain number of bodies which might display adverse health effects, or a certain number of malleable opinions to be persuaded.

Some of us felt that the conference officials and the proponents of nuclear power rarely revealed any awareness that we must address the needs of people as warm, emotional, sensitive, and complex wholenesses. People around us have psychological and emotional faculties, a sensitivity to pain, and a capacity for love and mutual concern that we cannot let ourselves ignore. Not the least, we have a moral sense to govern our actions surely as central to our nature as reason, logic, and the will to power. Yet because of its risks and demands, a nuclear technology must run roughshod over the humanity, the complex spirit, the intrinsic wholeness of people. But at no time were the costs of nuclear power to our humanity assessed, and at no time were they justified, except in mechanical, materialistic, and soulless terms.

Moreover, many of us feel that to strip from the discussion its social-political-economic context (in the broadest sense) is to deprive the discussion of meaning. A much fuller discussion of the historical setting and implications would be extremely desirable.

In the focus of this forum upon the health and safety of human beings, some of us found a lack of concern for the intrinsic value of other biological organisms or of the earth's environment as an entity. We urge EPA to view its criteria within a less anthro[po]centric framework.

Finally, it is extremely important that EPA proceed toward the promulgation of final criteria with caution. The government has delayed this process for 30 years. Surely the production of truly excellent criteria for radioactive waste management--and their acceptance by the American people--are important enough to warrant a further delay in order to conduct numerous public meetings on the draft criteria throughout the United States. We offer to help you with these meetings. We nuclear opponents have been hard on EPA, but we consider what you are doing of paramount importance to our society and to the earth forever.

Despite all deficiencies, a number of us feel that useful, constructive dialogue was achieved in some areas. Moreover, we feel that further efforts may be rewarded by a deepening of mutual understanding and movement toward the goals of effective action which we all are seeking.

Signed,

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